HEALTH MONITORING ANALYTICS

Final Report
Software Engineering
Group #1

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http://www.healthmonitoringanalytics.com/HTMLApp2/public_html/index.php

1 Individual Contribution Breakdown

Task	Xianyi	Gradeigh	Rui	Li	Yihan	Xiaoyu	Total
Summary Of Changes (5 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.1: Customer Statement of Requirements (6 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.2 Glossary of Terms (4 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.3 System Requirements (6 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.4 Functional Requirements Specification (30 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.5 Effort Estimation (4 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.6 Domain Analysis (25 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.7a: Interaction Diagrams (30 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.7b: Design Patterns (10 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.8a Class Diagram and Interface Specification (10 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.8b OCL Contract Specification (10 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.9: System Architecture and System Design (15 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.10: Algorithms and Data Structures (4 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.11: User Interface Design and Implementation (11 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.12: Design of Tests (12 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec.13: History of Work, Current Status and Future Work(5 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
Sec. 14: References (5 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
PROJECT MANAGEMENT (17 points)	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	100%
TOTALS (points)	33.4	33.4	33.4	33.4	33.4	33.4	200

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2 Summary of Changes

Our project goals from the beginning have changed substantially. Below are an itemization of some of the most relevant changes.

- We no longer put an emphasis on integrating user experience and social engineering with the product. It was far too ambitious in the planning stages to execute the ideas we set out with given the level of resources within the team.
- User profiles and discussions about users and use cases related to users have been removed.
  - There are still references to users and profiles in this report. Section 8 preserves a class diagram that could be used with an updated product that has users in it.
  - There are deprecated use cases that can be seen in several sections, e.g. 12.1.1 and 12.1.2. These are preserved for posterity.
- There are several removed references to community tracking and providing health suggestions. This is far too difficult of a task to carry out. We instead narrowed our focus to more simple health tracking of the United States rather than specific communities.
  - As such, we have struck out this concept of a "hot city" and instead focus on state-level segregation of tweet data.
- We streamlined our use cases down into the few that the system now implements. There are clarifications added to specific use cases that deal with issues on using the software.
- The algorithms section has been updated to match our statistical analyses and useful equations when dealing with the weight of the word cloud.
- There are discussions on filtering that can be seen in the section on Interaction Diagrams.
- Several sections have been updated in the sense that they add more descriptions on the final product as well as just cut down on material that is no longer relevant and this applies to most if not all sections (including the Customer Statement of Requirements).

3 Customer Statement of Requirements

3.1 Problem Statement

To our devoted consumer base, It is our belief that the most important factors to a happy and healthy life is physical exercise and a balanced diet. We can work our fingers to the bone and party to our limits but it isnt possible to live the most balanced life without first balancing our health. Some of you out there struggle with a variety of conditions related to your health: type 2 diabetes, high blood pressure, high cholesterol, et cetera. It would be much easier to manage these illnesses or even eradicate some of them if you could work up the will to exercise. It is often too late for many of you to realize that theres something wrong until your body hits a point of peak physical distress; communicating through you with the use of pain. Pain is an undesired signal because:

- You do not enjoy pain.
- It arises in moments of severe distress; i.e. when something has gone wrong enough to the point of medical attention.
- It often comes too late when you'd want to anticipate the problems pain is alerting you to in advance.

We here at our organization understand the various problems related with exercise. In a poll of our customers, the most likely reasons why you don't exercise can be found on this list:

- No time
- No energy
- Competing interests
- Haven't developed the habits
- No motivation
- Too overwhelming
- Poor diet
- Current physical condition
- No access
- Lack of results

So how can we work together, you, the consumer, and us, the company, to break down these barriers to entry for a healthier life? We have heard and understand your complaints, and well take this opportunity now to explain how we think we can help you get in shape! The operating principle is this: man is a social creature; it does not do well on its own

and needs community support to survive and thrive. This logic can be applied to you, the consumer, as well; you are more likely to perform a task if you know you will have a compatriot along for the ride. As such, we know you can be motivated to exercise by seeing people you know working-out (and subsequently joining them) or by meeting more people in your community who exercise as well, transforming a previously solo venture into a social activity. We posit the following to you: there exists a definitive culture around those who exercise regularly; it is not uncommon for people to be swept up in the exercise habits of their friends. If your friend starts cycling as part of their commute and tells you that it gives him/her clarity of mind, freedom of transport, and exercise as if that is an afterthought then you are more likely to also start cycling in some way. There is no guarantee but it can be asserted that at least the probability that you will take up cycling as a means to better yourself. Fundamentally, this operating principle of exposure and awareness can serve as a hook to a healthier lifestyle. Visual impacts cannot be ignored either; what if strangers witness the newborn cyclist on his commute? It wouldnt be wrong to assume that this could serve as the spark for an engine of change in yet another person to begin cycling: If them, why not me? Now there is a domino effect of changing peoples lifestyles for the better. What we assert now formally is the power of the acquaintance, the friend, to influence both you and their community-at-large by extrapolating the bicycle example to all types of exercise.

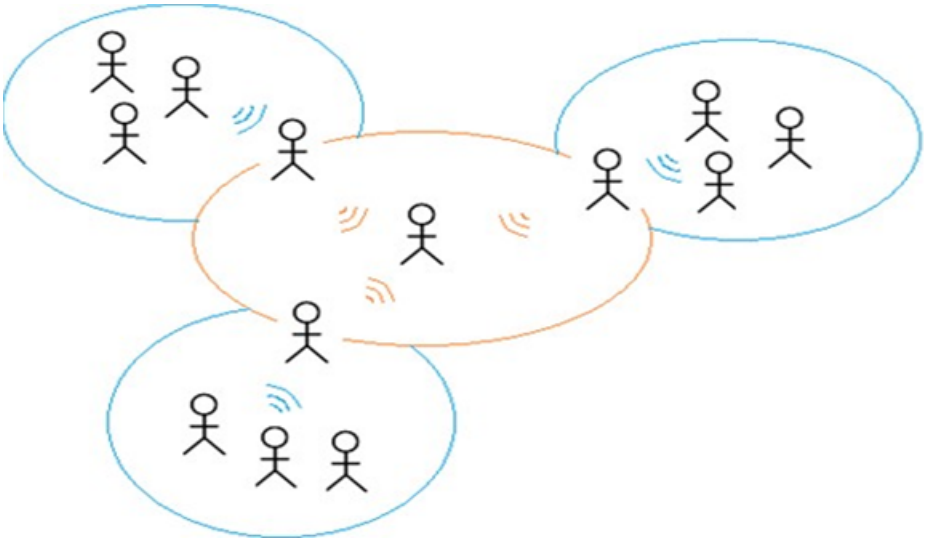


Figure 1: The community influencing a user.

This is all well and good. But we know that many of you have voiced that you lack the social structure that would encourage this type of domino effect. More specifically, you may lack friends or acquaintances who exercise daily and eat right or have not been impressed upon by the friends you have about the importance of exercise in a fulfilling life. So the question is no longer: How do I exercise? but How can I meet people who exercise? and How can I find out how much of my community is exercising? This additional question is important because we are, at our cores, competitive creatures. You are willing to better yourself to match your community if you can. And this, finally, is where we step in to help you, the customer.

To solve your problem, we plan to design and implement software to track the health activities of your community, analyze the progress as a whole, and feedback the analysis to you as a motivator. We intend on keeping track of whether your community becomes healthier or at least more physically active as a whole by aggregating any and all available data in your neighborhood and surrounding communities. And there already exists a veritable ocean of information to draw from: Twitter! This real-time social media engine generates tweets by the thousands per minute on any variety of topics; the goal would be to focus on the health related aspects and localization of the tweets.

With the big data analysis, we would be hoping to target some of the issues relating to why people dont exercise:

- For many of you, no time is a baseless complaint; it often arises among those who are unable to manage time effectively themselves. Obtaining a map of someones daily using tweets can allow us to, if effectively compared against a person who has similar time constraints that is exercising effectively, generate a plan of action or socially network the lazy man and the exercising man together.

- We should be able to provide a means to understand why a person has no energy from their social media data, if there is any. A mechanism should be put in place to provide suggestions on how to improve their energy for exercise, be it comparison to their friends, small changes in diets (using advertising), or adjusting their schedule to find hours of the day where they dont feel tired and suggesting exercise there.

- For the problem of competing interests, a person could be informed about a type of opportunity cost related to doing one task versus not exercising at all.

- This part is easy enough; it is only necessary for the person to be informed about how their friends might be changing their activities or by viewing the status of a community health board.

The last issue to address is of a personal nature to you, the consumer. We want the software to be free and readily available to you at no cost. We expect it to be easy to find what type of information you are looking for. We want you to be able to use wherever you want; mobile or desktop. We also want to implement privacy options so that you have total control over what you are showing to your friends or to your community, but we hope you will share as much as possible! It takes a village to make a man.

3.2 Background on Health Monitoring Analytics

Most systems today for personal activity monitoring focus on the benefits and rewards for an individual user. The user may share this information with his or her friends, but everything revolves around an individual. We have aggregated some active research work in analyzing the health of an entire community based on big data from a social network.

1. Healthcare Hashtag Project

Figure 2: The front page of the Healthcare Hashtag Project

The stated goal of this project is to make the use of Twitter more accessible for providers and the healthcare community as a whole. How it works is that users are able to use a search bar to scan the web for relevant hashtag data. The web would then extract data from Twitter and display it in an analyzed, digestible form for the user. Users can it to search for specific topics in natural language or by a specific hashtag. People can find where the healthcare conversations are taking place, discover who to follow within your specialty or disease, and find the best from conferences in real-time or in archive. Unfortunately, this is more focused on an academic/research type of community. It is used to globalize and clarify health care specific topics (diseases, et al).

2. HMS Health Monitoring Systems

   The EpiCenter system is capable of analyzing healthcare data for the purpose of detecting anomalies suggestive of public health threats, such as disease outbreaks and bioterrorism. Users can find reported data based on the location, settings and other options. However, the system is not able to reflect the actual condition of the community which we know is changing in real time and is not specific; this is a macro scale application of analyzing the health of a community through viral outbreaks and is meant for hospitals and not communities.

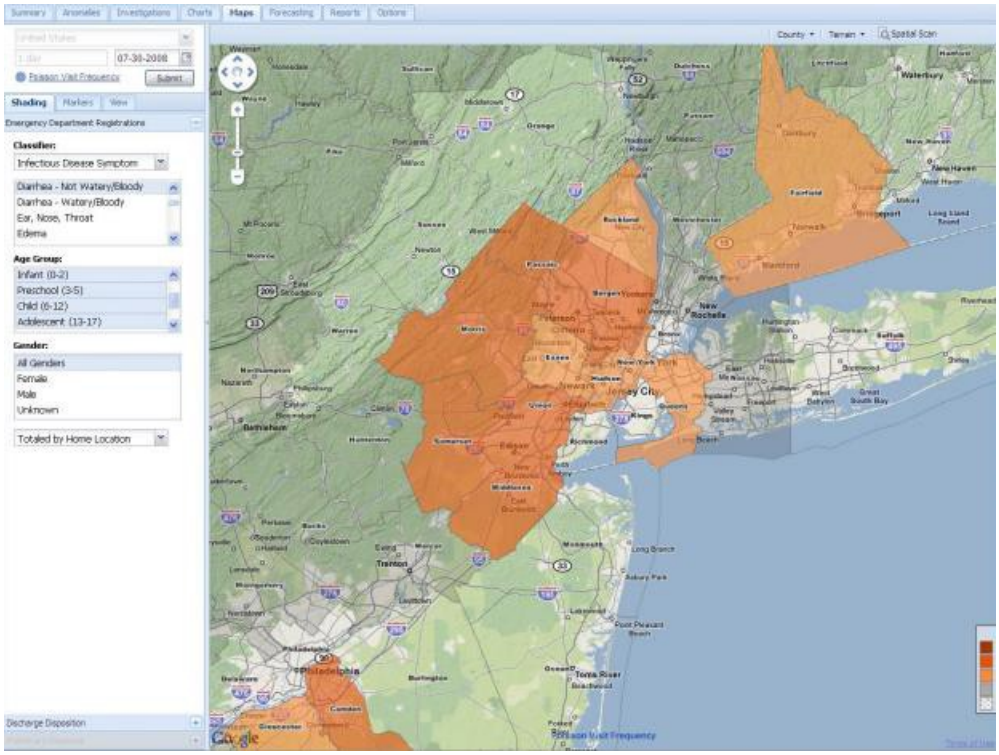


Figure 3: HMS: Health Monitoring Systems

These are the only two products we could find being offered to consumers and neither of them, even combined, fully implement what we plan to do here. So we can conclude, with some aplomb, that this approach is highly innovative.

3.3 Project Overview

To fulfill the requirements of our customer statement, we have defined the following criteria as being mandatory for implementation with the software:

1. Generate real time health statistics for a certain area
   We expect to be able to aggregate the Twitter data and extrapolate it to figure out how much of a community (or city) is physically active and how much it isnt. We also want to know the distribution of the involvement in different regions. This should be updated as soon as tweets involving exercise come in.

2. Heat Map
   Based on the existing tweets from Twitter, we developed a graphical representation of the distribution and concentration of the tweets across a given area; a heat map, where different colors indicate different intensity levels. And how much of a community (or city) is physically active in sports or other health related topics.

3. Marker Map
   We will also display an output of the exact tweet data in a location on a map that

is separate from the heat map. This gives us the more discrete nature of the tweets versus the distribution (although it can be used for that as well).

4. Tag Cloud
   Tag cloud is used to display the frequency of the hashtags used when querying Twitter for tweets.. The bigger the size of a hashtag is, the higher its frequency is. When clicking a hashtag, the user will be redirected to the Twitter search site that shows the most recent results for that tag.

4 Glossary of Key Terms

- Hashtags
  - A word or a phrase prefixed with a pound symbol (#). Its typically used in social media for denoting important phrases. On Twitter, its used for grouping topics.
- User/Customer
  - A person who uses the Health Monitoring Analytics software.
- Administrator
  - The person who is in charge of maintaining the software.
- Tweets
  - 140 character statements delineated by hashtags that we are using to analyze the health of a community.
- Database
  - This is where the tweet information is stored after being pulled from Twitter.
- Real-time Graphics
  - Used to illustrate aspects of regions of the United States as a function of how the tweets are distributed. Analysis types include tweet aggregation by hour of day, location, or distribution.
- Tag Cloud
  - A pictorial representation of the most frequent hashtags using the size or color of the words as a weighting factor.
- Heatmap
  - A pictorial representation of the distribution of the tweets by grouping close-by tweets together and assigning warmer colors to highly grouped messages.

5 System Requirement Analysis

5.1 Functional Requirements Table

ID	Priority Weight	Requirement
REQ-1a	5	System should retrieve data from Twitter.
REQ-1b	5	System should retrieve data from database.
REQ-1c	5	System should retrieve data from Google.
REQ-2a	5	System should filter data by hashtag.
REQ-2b	5	System should filter data by location.
REQ-3	5	System should store Twitter data.
REQ-4	4	System should display the distribution of data via a heatmap.
REQ-5	4	System should display all relevant tweets as markers on a map.
REQ-6	4	The system should display a chart showing aggregated tweet data based on the hour of day.
REQ-7	3	The system should provide statistics based on geographical region.
REQ-8	3	The system should provide a tag cloud to display the frequency of the used hashtags.
REQ-9	2	The system should link to Twitter when the tag cloud is clicked.
REQ-10a	1	The system should have a search function for users.
REQ-10b	1	The system should allow users to find facilities nearby.

Table 2: Functional Requirements Table

5.2 Non-Functional Requirements Table

ID	Priority Weight	Requirement
REQ-11	5	The system should require minimum maintenance, at most once per week.
REQ-12	4	Keep two copies of data for record in case of system failure.
REQ-13	3	The system should remain functioning in the event of an update to Twitters API.
REQ-14	2	The software shall present the graph and words in a neat and tidy website.

Table 3: Non-Functional Requirements Table

5.3 On-Screen Appearance Requirements

The following represents the initial draft of what should be major on-screen requirements. This is meant to be referenced with the figure below. The draft and this analysis has since deprecated.

1. Welcome/Landing Page:

   This is sort of the pre-website page. It displays information about what the interior of the website contains and gives the user an idea of what he can expect and invites them inside. A button would be on the screen somewhere that the user can press to enter the website.

2. Home Screen:
   This is more of the main page of the website. The home screen is the central hub for the user to interface with the system and access all of its functionalities. Once on the screen, the user would be faced with the following components:

   (a) Search bar:
   It allows the user to search for cities, communities, neighborhoods, relevant hash-tags, or other users.

   (b) Main Page:
   This is an area of the screen that displays relevant information based on what is typed into the search bar. If there is no text available, it will list the following criteria:

      i. Available cities - This is a list of hot cities relevant to the user.
      ii. Facilities- This is a list of exercise or health related venues in the surrounding area or in the hot cities.
      iii. Search results list - This lists the results of a given search when a query is entered into the search bar (see 1.).

   (c) Output window:
   This pane of the screen displays information about the community entered into the search bar or selected from the main page. This type of information includes: the current health of the population in the city, notifications about activities in the city, and statistical results.

   (d) Account drop-down menu:
   This portion of the screen reveals a drop down list of buttons for the user to interact with. This screen is mostly about preferences for the users profile.

      i. Log in - This button brings the user to the login screen where he may log in to the website.
      ii. Personal page - This button brings the user to his personal profile page.
      iii. Account settings - This button brings the user to the account settings page.
      iv. Log out - This button is visible only if the user is logged in and will log the user out.

(e) Google map window: This is a modified map ported over from Google Maps that displays the locations of facilities and tweeters in the system.

(f) Data analysis windows: This displays real time analytics of the communitys twitter data. A user can view a histogram, chart, etc; any type of analytic data for the community.

(g) Help link: This is a link that takes the user to the help screen.

(h) About link: This is a link that takes the user to the about screen.

3. Log in screen:
   This is a dialog box where the user enters his or her login name and password to gain access to his profile on the website. There exists a button on this box to register for the service and this button navigates the user to the registration screen.

4. Registration screen:
   This page is where the user enters their personal information to create an account for the software.

5. Help page:
   This is a page where tutorials are supplied for the user to help themselves learn how to use the system.

6. About page:
   This describes the motivation for the project.

7. Personal page:
   This is a page where the users personal information is displayed back to them along with other such relevant things like location, their recent activity, browsing history, search history, and social networks.

8. Account settings page:
   This page is where the user manages their personal account such as changing their login or password or location, et cetera.

A sketch is listed below that explain most of what this section has enumerated.

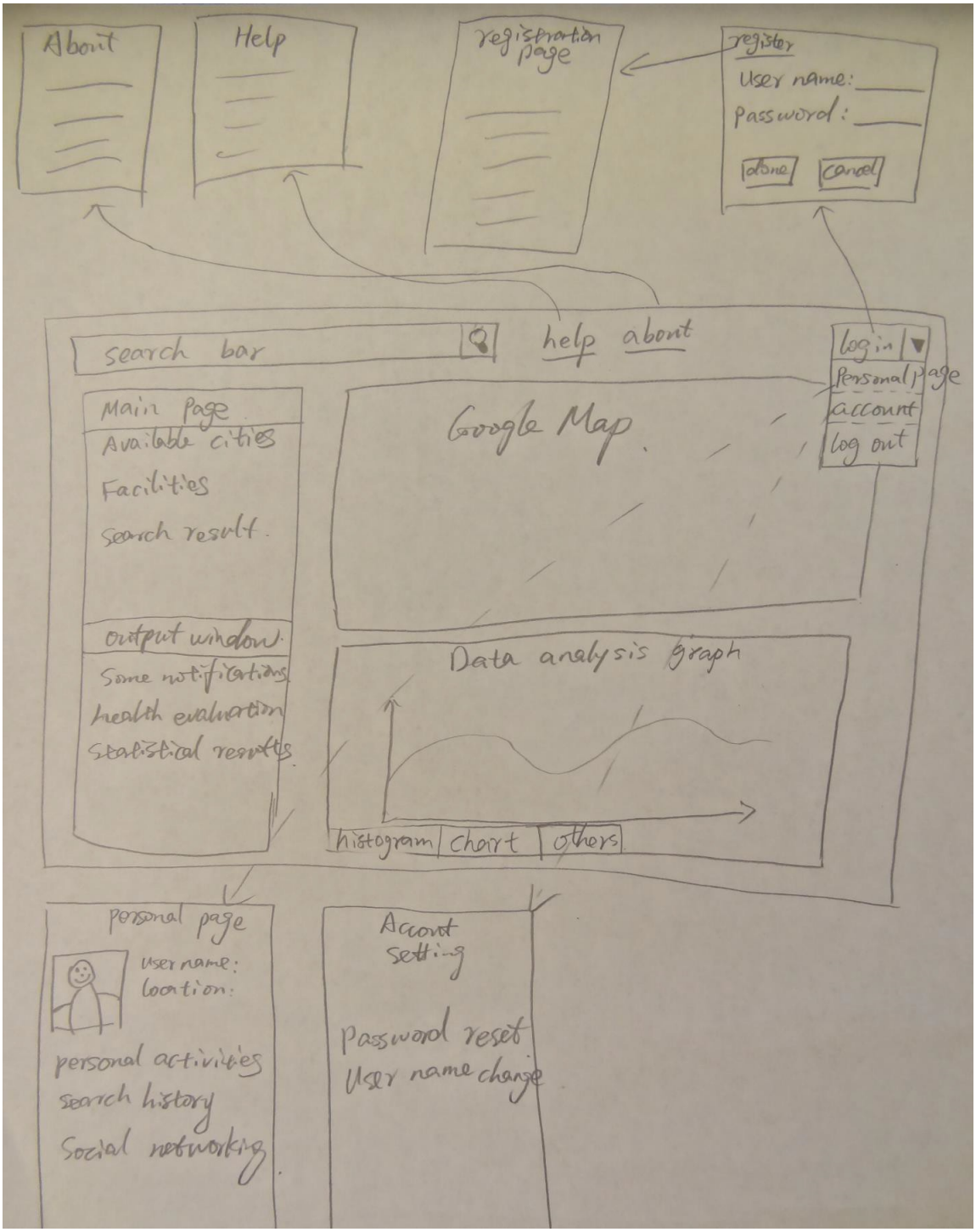


Figure 4: Paper prototype of the user interface.

6 Functional Requirements Specifications

6.1 Stakeholders

1. Fitness Buffs

   These are considered the most serious of people in the system; they are people who spend an inordinate amount of their time on managing their health and well-being, typically working-out around 3 6 hours per day and managing their intake of vitamins, calories, complex sugars, carbohydrates, et cetera. There is no other person in the system who is as serious about their fitness as they are. Their interest is in their own fitness, almost exclusively.

2. Average Consumers

   The average consumer is a person who does not work out regularly but is interested in the system and what it can help them do. The system is geared towards helping this subset of person by encouraging them to work out and broadcast their activities while monitoring the community at large. Their interest is in using the system to improve their health and in the health of his/her community.

3. Business Owners

   Business owners are, more narrowly, people who own or operate gyms, health food stores, health products lines, et cetera. Their interest is in using the system to figure out how to target consumers that are more physically active and thus more likely to use the product or to find new venues in areas that are lacking them but have the potential to support them.

4. Academics/Researchers

   This set includes those who work in universities or in corporate research that are working in fields that require aggregation and analysis of data related to the health of communities. The members could be from many different disciplines: nutrition, dietetics, psychology, sociology, et cetera. Their main interest is in using the system to further research results.

5. Government Officials Government officials is a highly diverse and wide spanning group that includes people from local townships and municipalities all the way to the state and federal levels with job titles ranging anywhere from councilperson to state senator. Their interest in the system is in using it to guide policies or reform for a targeted region by changing laws that could have an impact on health (e.g. Bloombergs soda ban in New York City).

6.2 Actors and Goals

1. User

- Initiating type

- Goals: To interact with the system to find information about the health of a region, to find people in his or her area who exercises a lot, and to leverage the systems full functionality to assist themselves in living a healthier life.

2. Administrator

   - Initiating type

   - Goals: To further develop the system and improve its functionalities as well as maintain the website and interface. Additionally, they perform customer service and deal with maintaining the members quality of interaction.

3. Web User Interface

   - Participating type

4. Tweets Database

   - Participating type

5. Google

   - Participating type

6.3 Use Cases

6.3.1 Casual Descriptions

- UC#1 Searching for Locations and Facilities
  Requirements: REQ1c, REQ11a, REQ11b The user wants to perform a search for locations or facilities nearby such that they can evaluate the statistics for that area for their own perusal. They will be required to navigate to the search bar and enter a query and then press Enter.

- UC#2 Viewing Statistical Breakdown
  Requirements: REQ1a, REQ1b, REQ3, REQ6, REQ7
  The user wants to view the statistical breakdown for the geographical regions of the United States. They will navigate over to the charts and graphs region of the website to view information such as: tweet data broken down by location, where the most frequent tweets are coming from, and what time of day the most tweets are being generated.

- UC#3 Viewing Results
  Requirements: REQ1b, REQ2b, REQ3
  The user wants to view how many tweets are collected, how many tweets come from the U.S., how many of them have a location, and what fraction of the population that is tweeting is exercising.

- UC#4 Viewing Map
  Requirements: REQ1b, REQ1c, REQ2b, REQ3, REQ4, REQ5
  The user wants to know how the tweets are distributed graphically using a map. The user can view the information as a distribution via a heatmap or directly view all of the tweets plotted on a map, where the marker can be interacted with to show the content of a tweet.

- UC#5 Viewing Word Cloud
  Requirements: REQ2a, REQ3, REQ9, REQ10
  A user wants to view a word cloud containing the hashtags used to filter the data. They will visit the website and view the word cloud from their home page which could reflect the frequency of the hashtags depending on the size of the tag inside of the cloud. Clicking on the tag will take the user to Twitter.

6.3.2 Use Case Diagrams

The use case diagram is shown in the figure below. Member, Visitor and Administrator "initiate" all use cases, except for UC-2 (Choose Hot Cities), which is "extend" from UC-1 (Location/facilities Search) as sub-use-case. Database A store tweet data for Member and Visitor. Database B store members information for Member and Administrator. Thus, they are "participate" in all use cases. Member is generated from a Visitor when the Visitor chose to run UC-10 (Register).

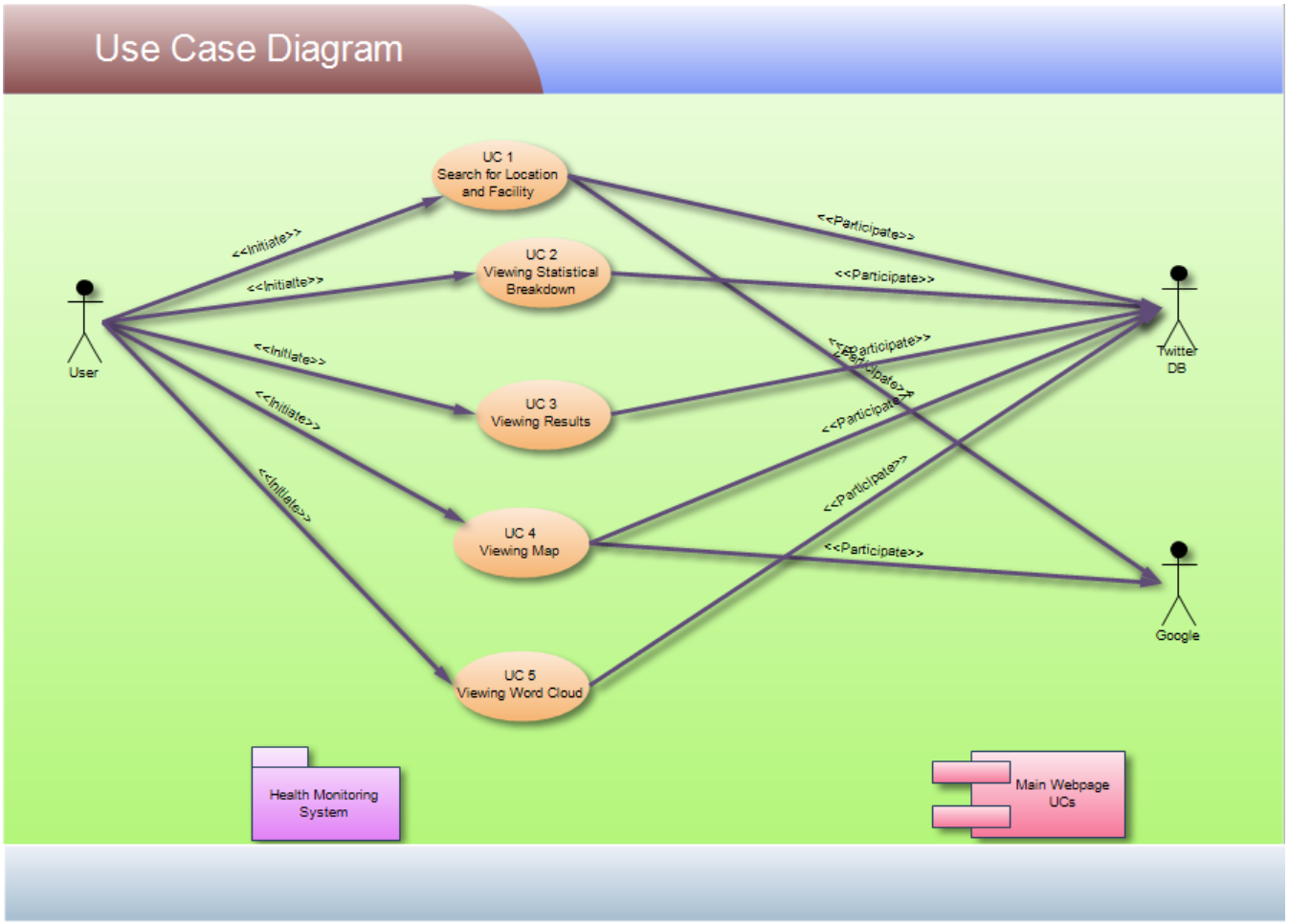


Figure 5: Use Case Diagram

6.3.3 Fully Dressed Descriptions

- UC#1 Searching for Locations and Facilities
  Initiating Actor-Member
  Actor Goal- To search available location or facilities.
  Requirement Addressed - REQ1c, REQ10a, REQ10b
  PRE-CONDITION- No precondition
  POST CONDITION-The user could achieve results they want. Flow of events:

  1. The user, visitor or member, types in his interested location/facility.
  2. The system requests for the data from Twitter database about the tweets from a location or about some facilities information.
  3. The raw data get analyzed in data analysis component of the system.
  4. The statistical and graphical results are shown in the interface page.

- UC#2 Viewing Statistical Breakdown
  Initiating Actor - Member

Actor Goal - To view statistical breakdown
Requirements: REQ1a, REQ1b, REQ3, REQ6, REQ7

PRE-CONDITION- Data must be present in the database
POST CONDITION- The information is displayed to the user
Flow of events:

1. User goes to the main page to view the data
2. Data, if present in the database, is pipelined to the user
3. Charts are populated and presented as a breakdown

- UC#3 Viewing Results
  Initiating Actor- Member
  Actor Goal- To view results Requirement Addressed REQ1b, REQ2b, REQ3
  PRE-CONDITION- Data must be present in the database
  POST CONDITION- The information is displayed to the user

  1. User goes to the main page to view the data
  2. Data, if present in the database, is pipelined to the user after filtering
  3. Results buttons at top are populated and presented numerically

- UC#4 Viewing Map
  Initiating Actor- Member
  Actor Goal- To view maps
  Requirement Addressed REQ1b, REQ1c, REQ2b, REQ3, REQ4, REQ5
  PRE-CONDITION- Data must be present in the database, Google connection must be open
  POST CONDITION- The information is displayed to the user

  1. User goes to the main page to view the data
  2. Data, if present in the database, is pipelined to the website
  3. Map fragment is loaded in by Google
  4. The map is populated with various tweets after geographic filtering
  5. User can view the map breakdown

- UC#5 Viewing Word Cloud
  Initiating Actor- Member
  Actor Goal- To view results Requirement Addressed REQ1b, REQ2a, REQ3, REQ8, REQ9
  PRE-CONDITION- Data must be present in the database, Twitter website must be available
  POST CONDITION- The information is displayed to the user

1. User goes to the main page to view the data
2. Data, if present in the database, is pipelined to the website
3. Word weight size is calculated using hashtag frequency
4. Weights are updated, cloud is shown to the user

6.3.4 Deprecated Use Cases

These are use cases that are no longer viable because project goals to implement member functionality could not be completed in the given time and with the team resources.

- UC#5 Accessing Personal Page
  The user wants to access their personal page in order to peruse what the public can view about them (the user). User will need to click on their name in the top right of the screen or access the page through a drop down window.

- UC#6 Editing Personal Information
  The user wants to change his/her information. User will need to click on the Edit Personal Information tab and the system will navigate them to a series of fields where they can change their personal information.

- UC#7 Sending Messages
  The user wants to message a fellow user or administrator about an issue. They will need to interact with the website by creating a new message, entering the user information of the person they want to message, enter the message they wish to send, and then click Send.

- UC#8 Viewing Search History
  The user wants to view their search history to see things theyve looked at in the past either because they are curious or because they have forgotten something and wish to find it again. The user will need to go to their Personal Page via UC#5 and select View Search History tab.

- UC#9 Changing Account Settings
  The user wants to modify what they see on their personal page or what another user would see on the users page. User will head to the Change Account Settings tab and make alterations in various fields corresponding to what needs to be changed.

- UC#10 Registering
  A user wishes to register a new account so that they can use the program; alternatively, an administrator may want to generate additional accounts for whatever reason. Account creation requires that the user enter their full name, password, email, birth date, and an array of optional information (Twitter handle, Facebook page, et cetera). The user will navigate to this screen via either logging out if they are logged in and hitting Sign Up or by finding the option on the landing page if they are not already users. A registered users information is entered into the Member Database.

- UC#11 Backup Member Data
  An administrative user wants to back up database memory in the event of runtime failure. They will requisition the system to store data in parallel; one set is actively updated during system runtime and the other set is updated periodically by polling the active set.

- UC#12 Deleting Member Account
  A user wants to delete their account because they are either not using the service anymore, have made a new account, or are taking a leave of absence from it. They will have the option of permanent deletion from the member database versus a suspension of the account where it can be reactivated but is no longer visible by other users.

6.4 Traceability Matrix

UC#	1	2	3	4	5
Req #					
1a		x			
1b		x	x	x	x
1c	x			x	
2a					x
2b			x	x	
3		x	x	x	x
4				x	
5				x	
6		x			
7		x			
8					x
9					
10a	x				
10b	x				

Table 4: Traceability Matrix

6.5 System Sequence Diagrams

The traceability matrix shows the distribution of the requirements for each of the use cases.

These use cases are the key features of our software. Any user of our software can access these. The user will interact with the the system (the website) and from there the websitre will interact directly with the database and pipeline results back to the user.

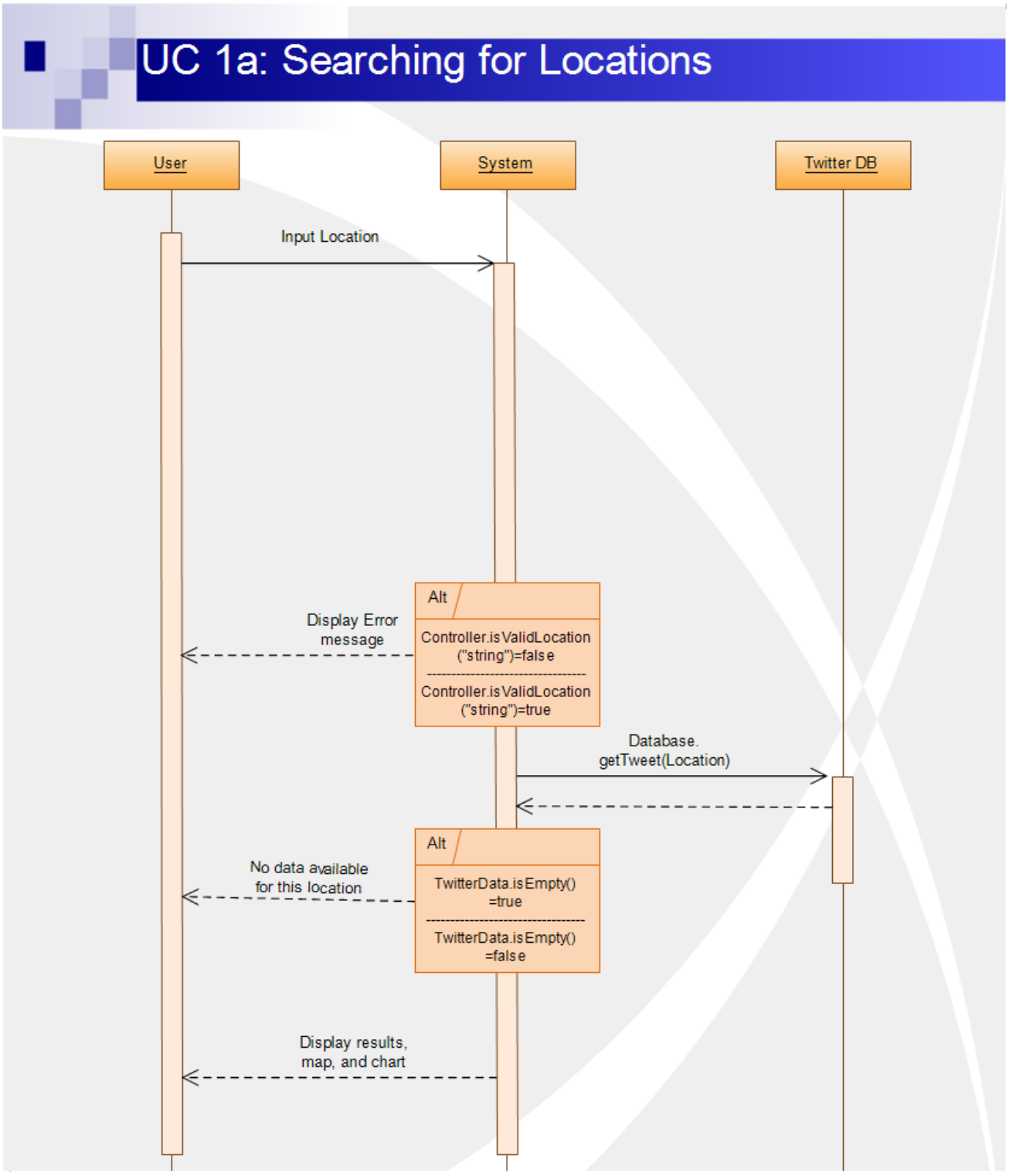


Figure 6: Use Case Diagram 1a

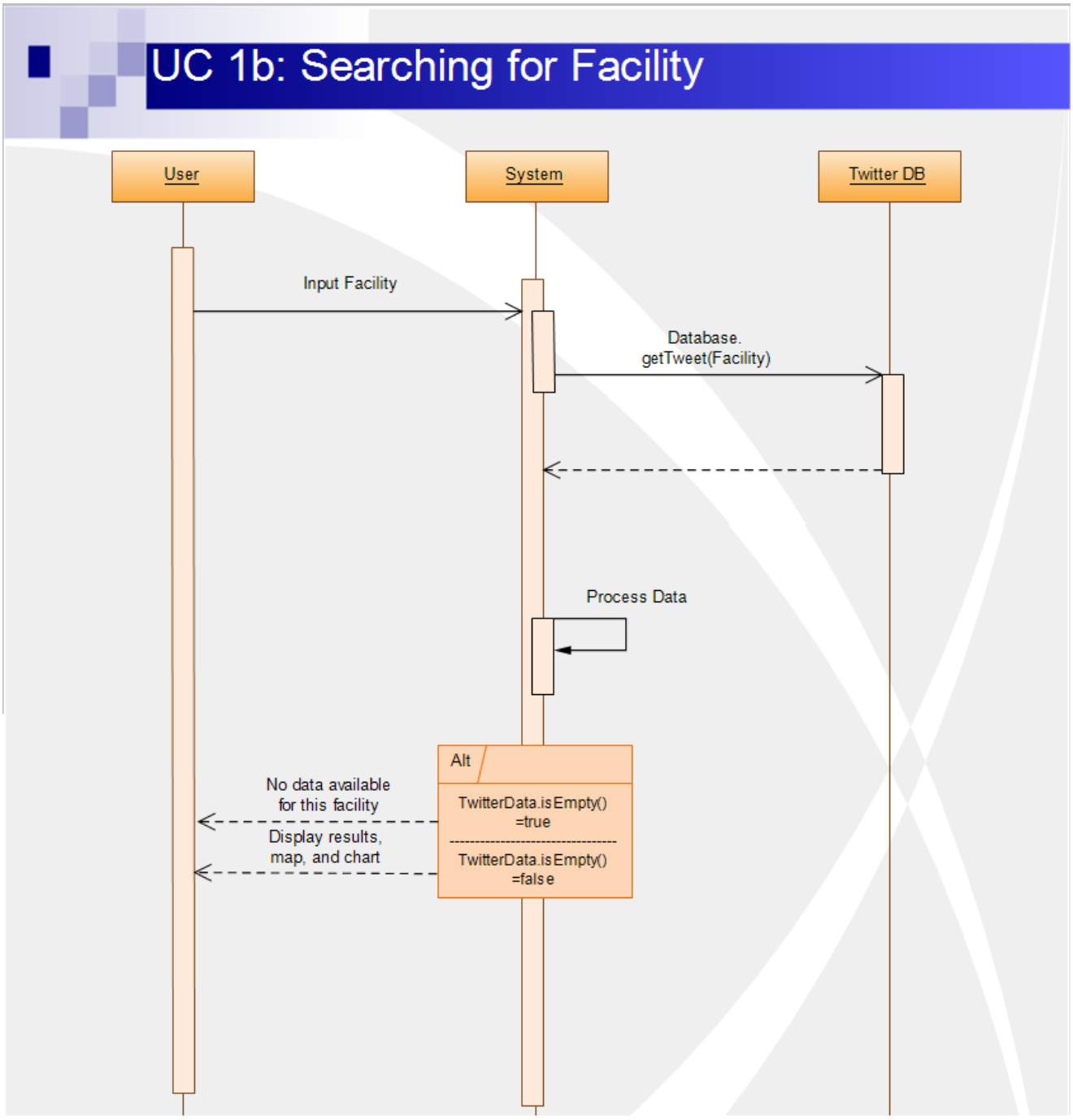


Figure 7: Use Case Diagram 1b

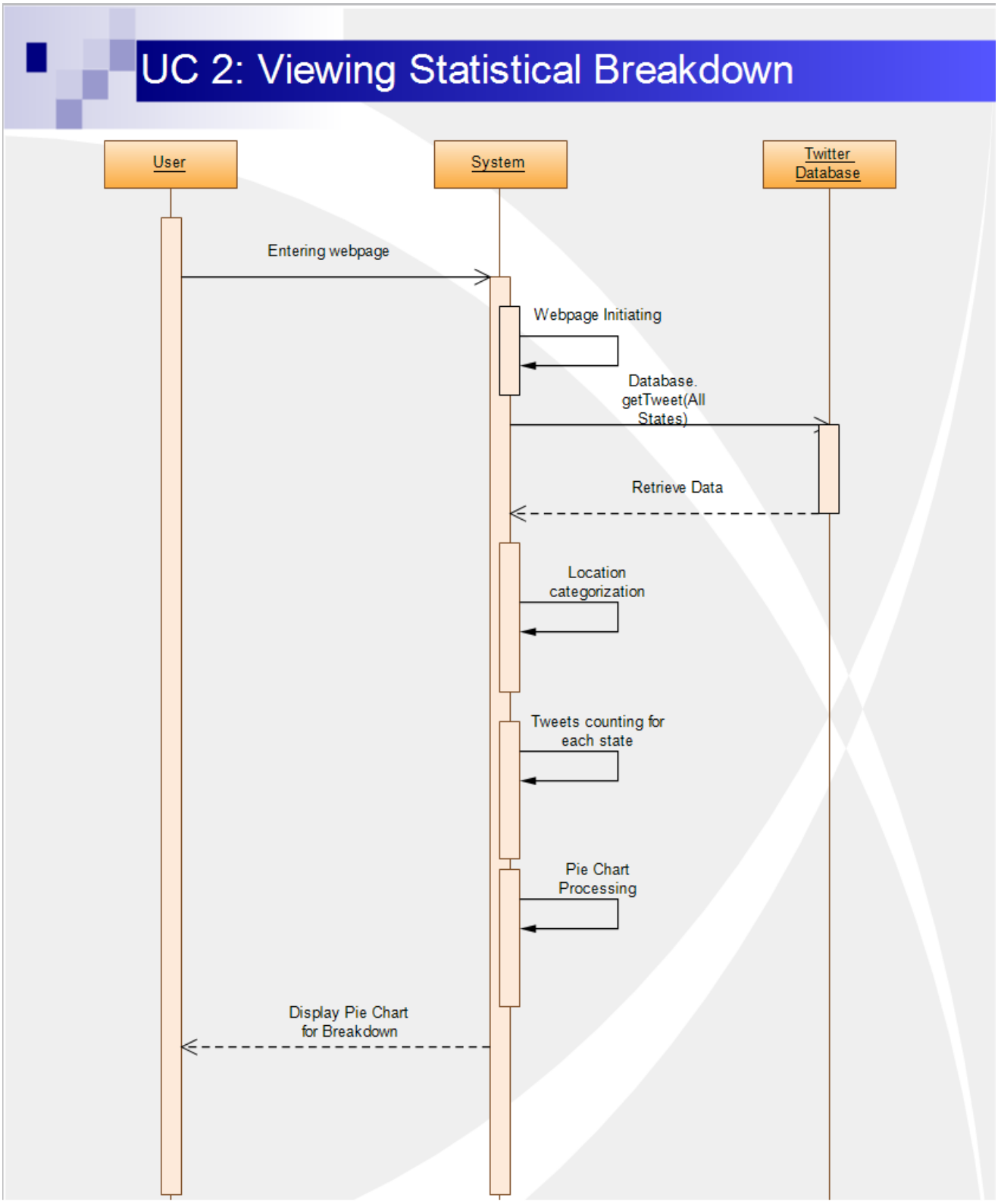


Figure 8: Use Case Diagram 2

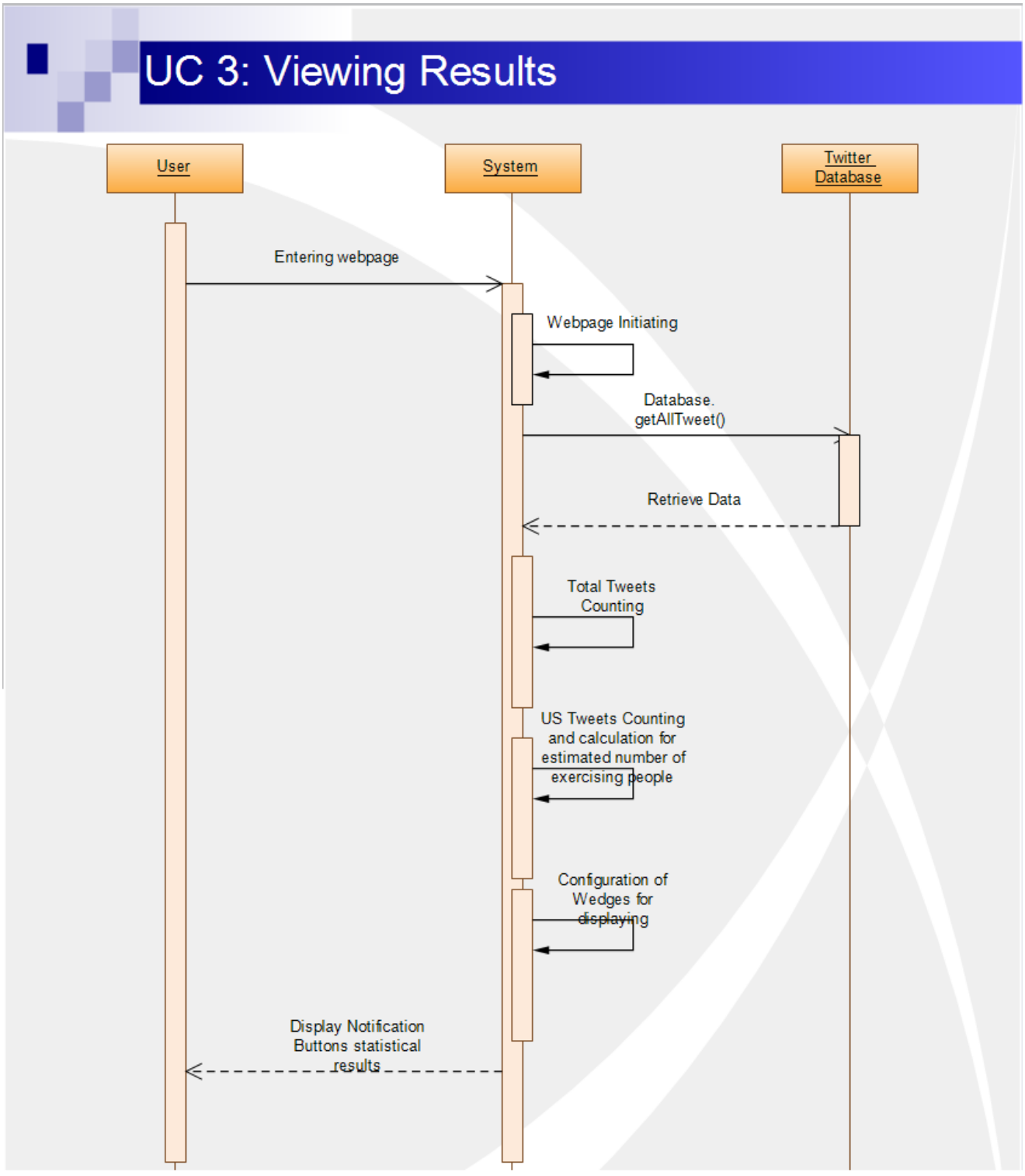


Figure 9: Use Case Diagram 3

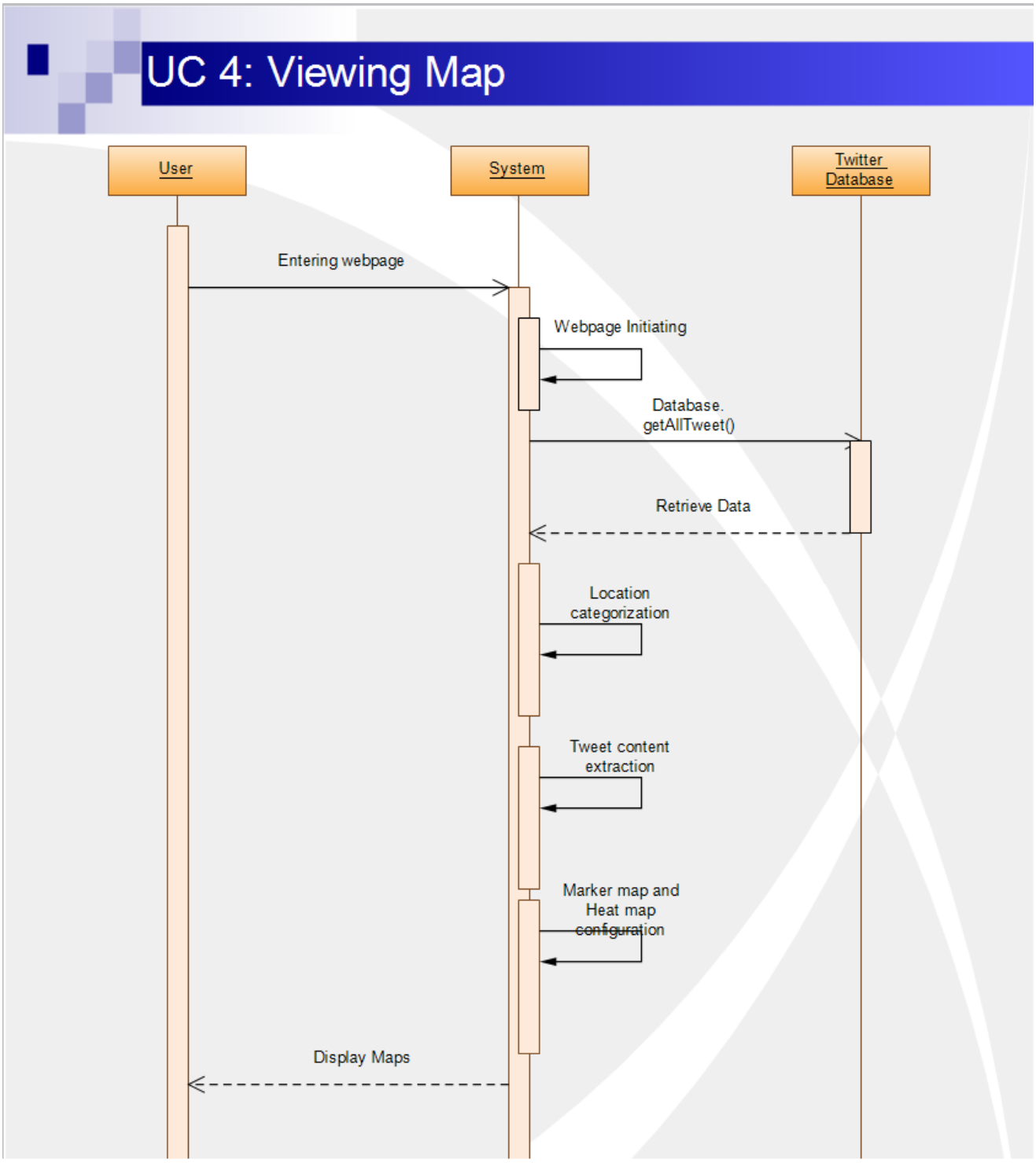


Figure 10: Use Case Diagram 4

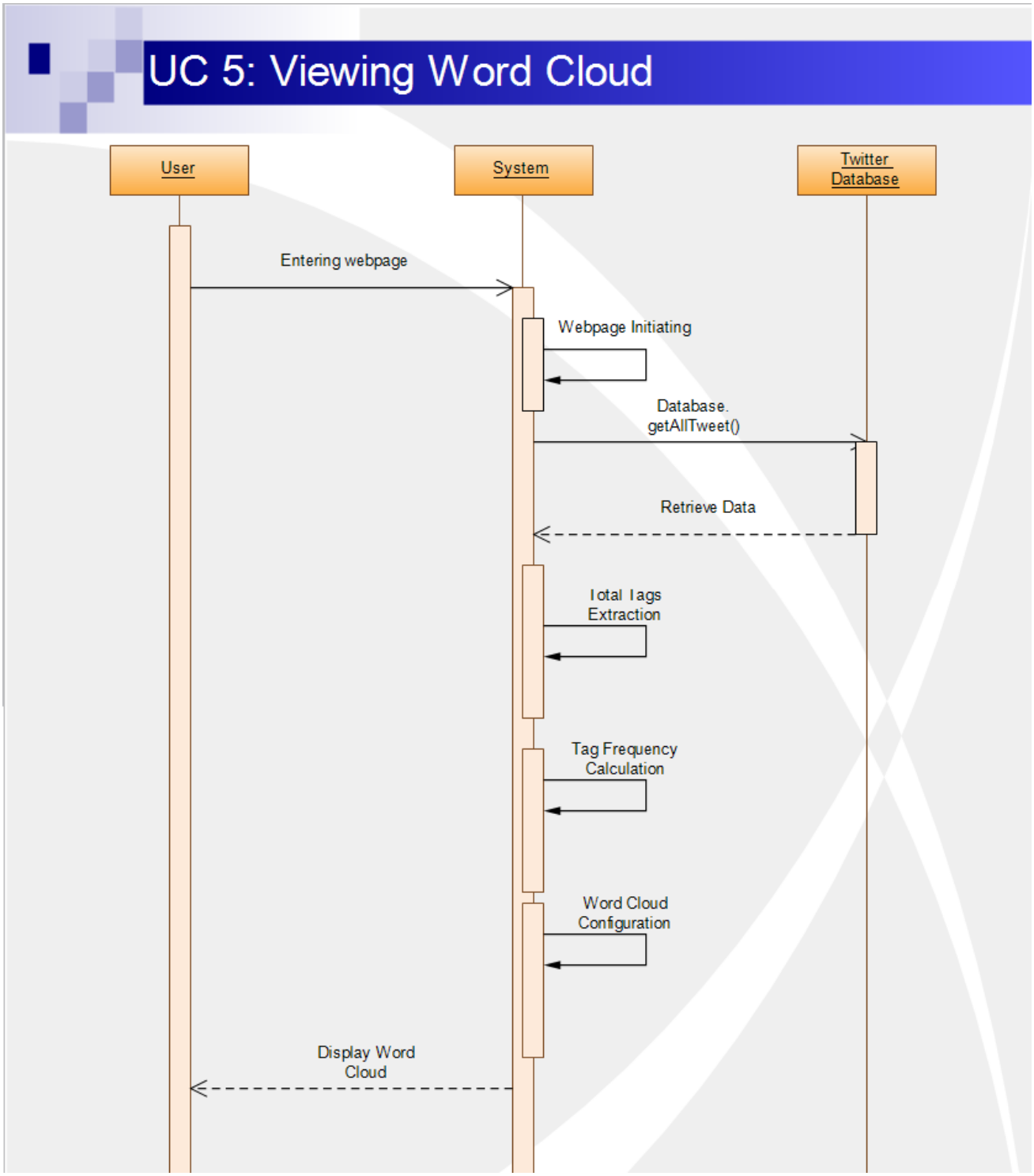


Figure 11: Use Case Diagram 5

7 User Interface Specification

7.1 Preliminary Design

This section represents our preliminary design and analysis. It is not updated to match the current specs because it was initially planned as a drafting proposal. Many things mentioned here are not implemented such as member databasing or logging in. Here is the proposed main user interface webpage:

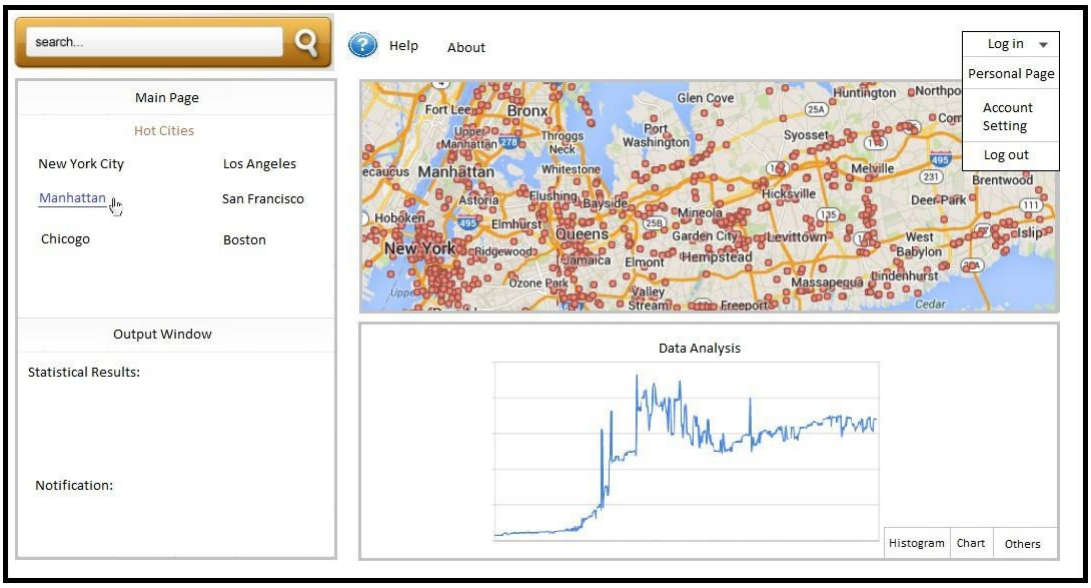


Figure 12: User interface specification draft.

1. The visitor (user who is not registered) can input one of his/her interested cities in the search bar, and hit search icon. The google map will zoom in to the corresponding city and the tweeter users locations will be marked red in the map as shown in Figure 4-1. The tweeter users who mentioned physical activities or concerns about health in their tweets will be marked in different color (blue for example). The visitor will clearly see how the distribution spreads within this city. The map also enables dragging and zooming in/out. The output window will show the statistical results estimating the percentage of the tweeter users who actually mentioned about health in this particular city. In addition, the output window also shows some notifications depending on how this citys health awareness comparing to other cities in our database. For example, if the city shows low percentage of people mentioned about physical activities and health concerns, the system will output a notification saying, According to our analysis, this city has relatively low health activities comparing to others. People in this city are encouraged to exercise more. Or some notification about how it is changing with time.

   For example, The health activity is decreasing recently in this city. The data analysis window will show the variation of this statistical result (in percentage) corresponding to time. The visitor can see how peoples awareness/concern of their health changes

over time in this city. It can also switch to other types of diagrams such as tables when the visitor click on the switching layout within this graphic window.

2. Alternatively, the visitor can click on one of the hot cities shown under main page section. Same results will show in these output windows as stated above. However, in this case, visitor doesnt have to input the city in the search bar.

3. The visitor can input a health facility in the search bar. The map will mark all the locations of the health facility in the United States. The visitor can zoom in to different cities to see the distribution of these facilities in different places. For example, searching for swimming pools would result in showing all large/popular swimming pool facilities in the United State. At the same time, the map will mark twitter users who mentioned similar topic in their tweets with blue dots and mark all twitter users in database with red dots. The visitor can see distribution and percentage of people mentioning about this facility or the corresponding activity.

4. The member (user who has registered) can use these two features stated above that all visitors can use.

5. The member can log in to use some additional features about accessing his/her own page, managing friends, and sending messages to friends.

6. For managing friends, a member can add a friend from a list of recommended members of our software who are interested in talking about health activities. A member may also delete a friend.

7. For sending messages, a member can send a message to a friend talking about heath topic or whether they want to walk out together.

Above are the main features for our software. More features would be added in as stated in the system requirements.

7.2 User Effort Estimation

Our system is very easy to use. We tried to design it with minimum user effort to accomplish their goal of checking community health activity awareness and entering simple social networking platform.

The visitor who just wants to check the health activities awareness in certain city and obtain some statistical data:

1. NAVIGATION (several keystrokes and one click)

    - Navigate to our software webpage (several keystrokes; inputting http address)
    - Main interface page is brought to the visitor
    - Close our webpage when finished (one click)

2. DATA ENTRY (several keystrokes and one click)

- Input city/facility in the search bar (several keystrokes)
- Click on the search icon (one click)
- The analyzed statistical data and graph will show to the visitor (0 effort)

3. Or Alternatively, (only one click)

- Click on one of the hot cities in main page window (one click)
- The analyzed statistical data and graph will show to the visitor (0 effort)

The visitor who wants to register to a member:

1. REGISTRATION NAVIGATION (two clicks)

- Click on log in button (one click)
- A new page pops up asking for user name and password, and an option of registration. (0 effort)
- Click on the register link (one click)
- A registration page pops up asking for information
- Done with registration

2. INFORMATION FILLING (several keystrokes)

- Account Registration Part 1 (Instructions and how to use the application)
- Account Registration Part 2 (Disclaimers and Permissions)
- Account Registration Part 3 (User information)
- Done with registration and a personal page is set at the same time.

The member who wants to add a friend:

1. ADDING FRIEND (five clicks and several keystrokes)

- Click log in button (one click)
- Input user name and password in the coming page (several keystrokes)
- Click done to go back to the main page (one click)
- Click on drawdown button and select personal page button (two clicks)
- In the personal page, look for a friend in the recommended list and click + symbol to add. (one click)
- Done adding a friend.
- The page will show the access to this friend.

The member who wants to send a message to a friend:

- Click log in button (one click)

- Input user name and password in the coming page (several keystrokes)
- Click done to go back to the main page (one click)
- Click on drawdown button and select personal page button (two clicks)
- In the personal page, select one added friend (one click)
- A message box shows up asking for message content.
- Type in message (several keystrokes) 8] Click send (one click).

8 User Interface Analysis

8.1 Domain Model

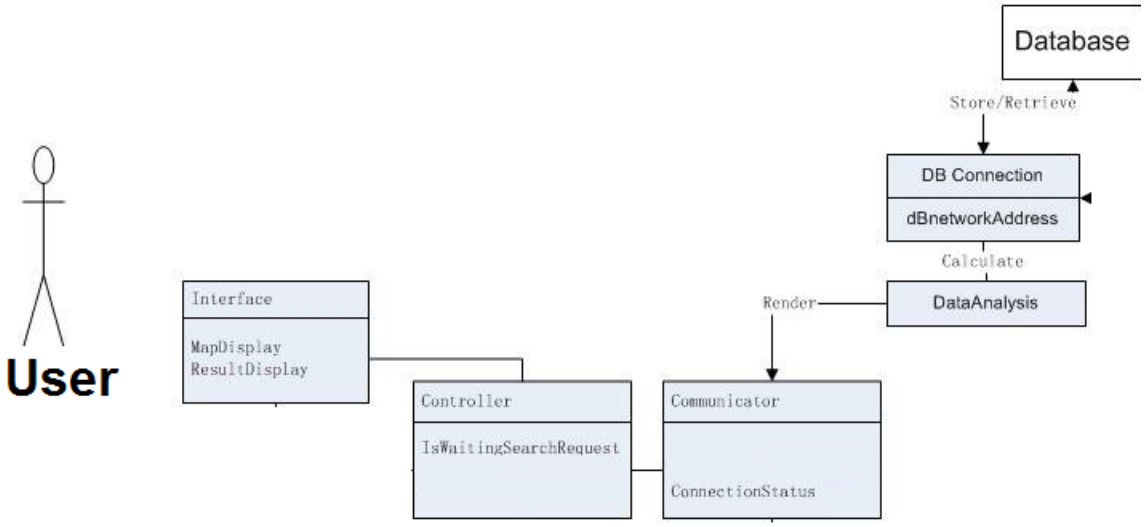


Figure 13: User Domain Model

8.1.1 Concept Definitions

To analyze the domain model, we first derive the domain model concepts and corresponding responsibilities from the formerly defined system use cases. Table 5-1 lists all the domain model concepts and corresponding responsibilities.

Responsibilities	Type	Concept
Handle requests from user	/	Controller
Display data in numerical/graphical form	/	Interface
Analyze data depending on the search request.	D	Data Analysis
Render search request to Tweet Database	D	Communicator
Access Tweet Database and execute request.	D	DB Connection
Receive notification from Data Connection	D	Controller

Table 5: Responsibilities, Types, and Concepts Table

8.1.2 Association Definitions

Some of the concepts defined above as domain concepts have to work in certain patterns to finish some target requirements. Table 5-2 gives the corresponding association definitions based on the defined domain concepts.

Concept Pair	Association Description	Association Name
Database DB	Connection Database forms a DBConnection to send information to the system.	Store/Retrieve
Data Analysis DB Connection	DBConnection passes the information from the Database to DataAnalysis.	Render
Database Data Analysis	Database sends information through Data Analysis to be processed.	Calculate

Table 6: Association Definitions

8.1.3 Attribute Definitions

Responsibilities	Attribute	Concept
Know if the user input keywords to search for data and information	Awaiting Search Request	Controller
Display a map to show results	Map	Interface
Display a list of results that have been searched	Search Result	Interface
Display analyzed data in visualized form	Data Display	Interface
Analyze data from Twitter database	Analyze Data	Data Analysis

Table 7: Attribute Definitions

8.1.4 Traceability Matrix

Domain Concept	UC1	UC2	UC3	UC4	UC5
Controller	x	x	x	x	x
Interface	x	x	x	x	x
Data Analysis		x	x	x	x
Communicator	x	x	x	x	x
DB Connection	x	x	x	x	x

Table 8: Traceability Matrix

8.2 System Operation Contracts

System Operation Contracts for the operations of the fully-dressed user cases.

- Searching for Locations and Facilities
  1. PRE-CONDITION- No precondition
  2. POST CONDITION-The user could achieve results they want.
- Viewing Statistical Breakdown

1. PRE-CONDITION- Data must be present in database
2. POST CONDITION-The information is displayed to the user.

- Viewing Results

1. PRE-CONDITION- Data must be present in database
2. POST CONDITION-The information is displayed to the user.

- Viewing Map

1. PRE-CONDITION- Data must be present in the database, Google connection must be open
2. POST CONDITION- The information is displayed to the user

- Viewing Map

1. PRE-CONDITION- Data must be present in the database, Twitter website must be available
2. POST CONDITION- The information is displayed to the user

8.3 Mathematical Model

8.3.1 Before Gathering Data

At any time, the user will want to perform analysis on city or location theyre searching for. The system will need to search for information based on tweets in the area, of which there are N. They will process data based on M hashtags identified b the system as being relevant to analysis. There are assumed to be A users in a given area that tweet about health and B users in an area that do not tweet about health (and are, for simplicity, assumed not health). For simple statistics, the analysis becomes:

$$\%\,Of\ Healthy\ Population = \frac{A}{A+B} * (Population\,Census) \tag{1}$$

8.3.2 After Gathering Data

There is always noise present in the data when we search for tweets and the system needs to compensate for that. There will be users who discuss information in a sarcastic way or attach hashtags to their tweets that are irrelevant to what theyre saying and can be mislabeled by the system. To compensate, we need to target a users tweet directly and then search their history. If their history gives an indication that they are health conscious or that theyve used this hashtag multiple times before in a relevant way (gauged by retweets), then the data is compensated. As time goes on, tweeters will be given a probability weight that their tweet is useful and compared to a threshold.

We collected all the tweets about health and exercise with a set of hashtags. After filtering out all the tweets having no information about location, we counted the number of tweets in US concerning about the health and exercise (noted as B). After researching online, we

found that 8% of US people use Twitter. Therefore, dividing the number of tweets from US by 8% (denoted as B/0.08), we get the number of people in US who exercise. But this is not the total number of people in US who exercise because we havent collected all the health related tweets in US. The tweets we obtained is just a subset of all health related tweets from US. As we collect more data, the number of collected tweets will increase, so as the number of people in US who exercise. Our estimated number will get closer and closer to the true value as time goes. There are some limitations on the accuracy of our estimated number of people in the US who exercise. We can only get closer to the true value by may never be able to reach that number. Another factor is that there may be more than one tweets about exercise sent out by one person. This person is counted more than once. Future improvement on this project can refine the algorithm to count the number of Twitter users who tweets about health and exercise instead of the number of tweets.

Originally, we were planning to get all the tweets from one area (either a city or a state). Then, we planned to find out the number of tweets having physical exercise information by finding some keywords from the tweet content. Then we will have the total number of tweets T and the number of tweets that are health or exercise concerned A. In that case, we can calculate the percentage of people in that area who concern about health and exercise. As we start implementing it, we realized that this is kind of impractical. The number of tweets from a city (for example NYC) is so large and the number of tweets mentioning health and exercise is so small. We have storage problem for the massive Twitter data and we would get a lot of noisy tweets (not related to health) at the same time. Therefore, we switch to some more practical ways. We only pull the tweets having specific set of hashtags. Although there is no any total number of tweets from one area for percentage calculation, we can still compare the difference in health related tweet number across different states. This also indicates the popularity of health and exercise across different states.

9 Interaction Diagrams

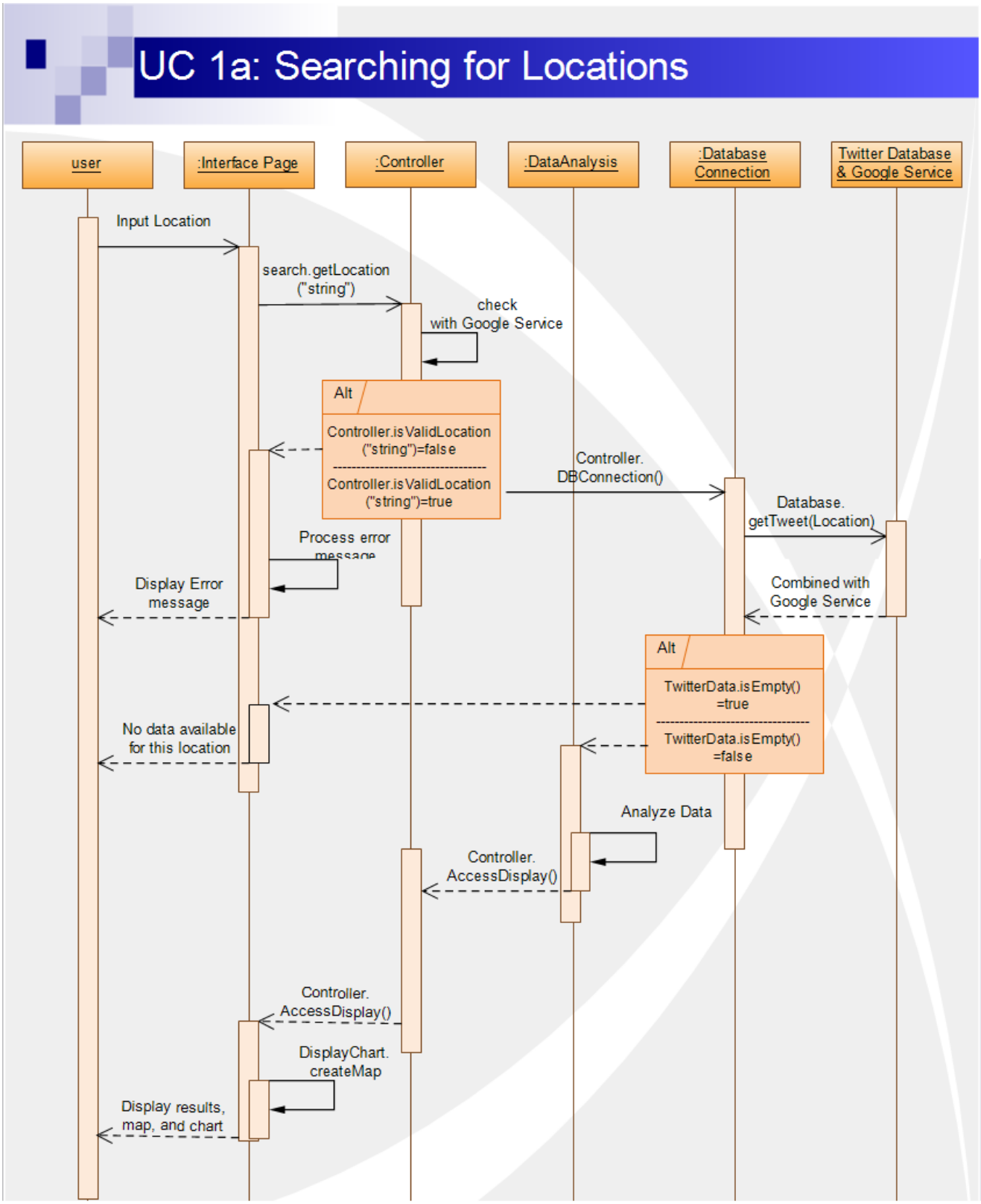


Figure 14: Use Case 1a: Searching for Locations

Use Case 1a is designed with the intention of giving the user the privilege of searching for location data through the user interface. This is important for the general functionality of the application; the ability to search for health-related data is the crux of the design goals. The interaction diagram displays the process the system needs to go through in order to handle a query from the user and correctly display the output. The user needs to navigate to the index page or any page of the website where the search functionality is enabled. From there, they can type their query into the search bar and wait as results are compiled for them from the system. There is visible error handling in the diagram for the instance where the strings are not valid (or if they are partially complete).

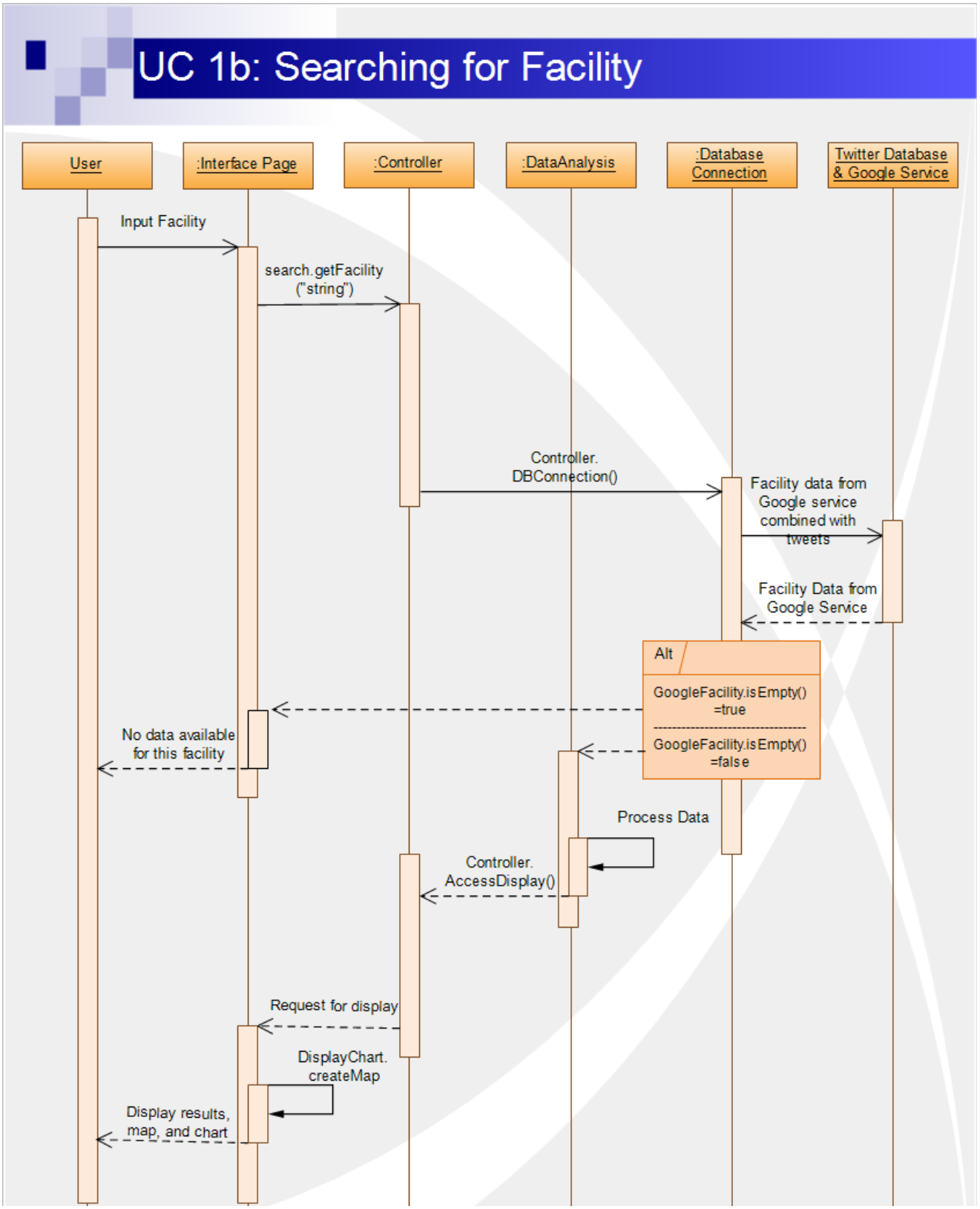


Figure 15: Use Case 1b: Searching for Facilities

Use Case 1b is designed with the intention of giving the user the privilege of searching for facility data through the user interface. This is important for less ancillary goals of the application; the ability to search for facility data is used to suggest places for the user to go rather than showing data. The interaction diagram displays the process the system needs to go through in order to handle a query from the user and correctly display the output. The user needs to navigate to the index page or any page of the website where the search functionality is enabled. From there, they can type their query into the search bar and wait as results are compiled for them from the system. There is visible error handling in the diagram for the instance where the strings are not valid (or if they are partially complete).

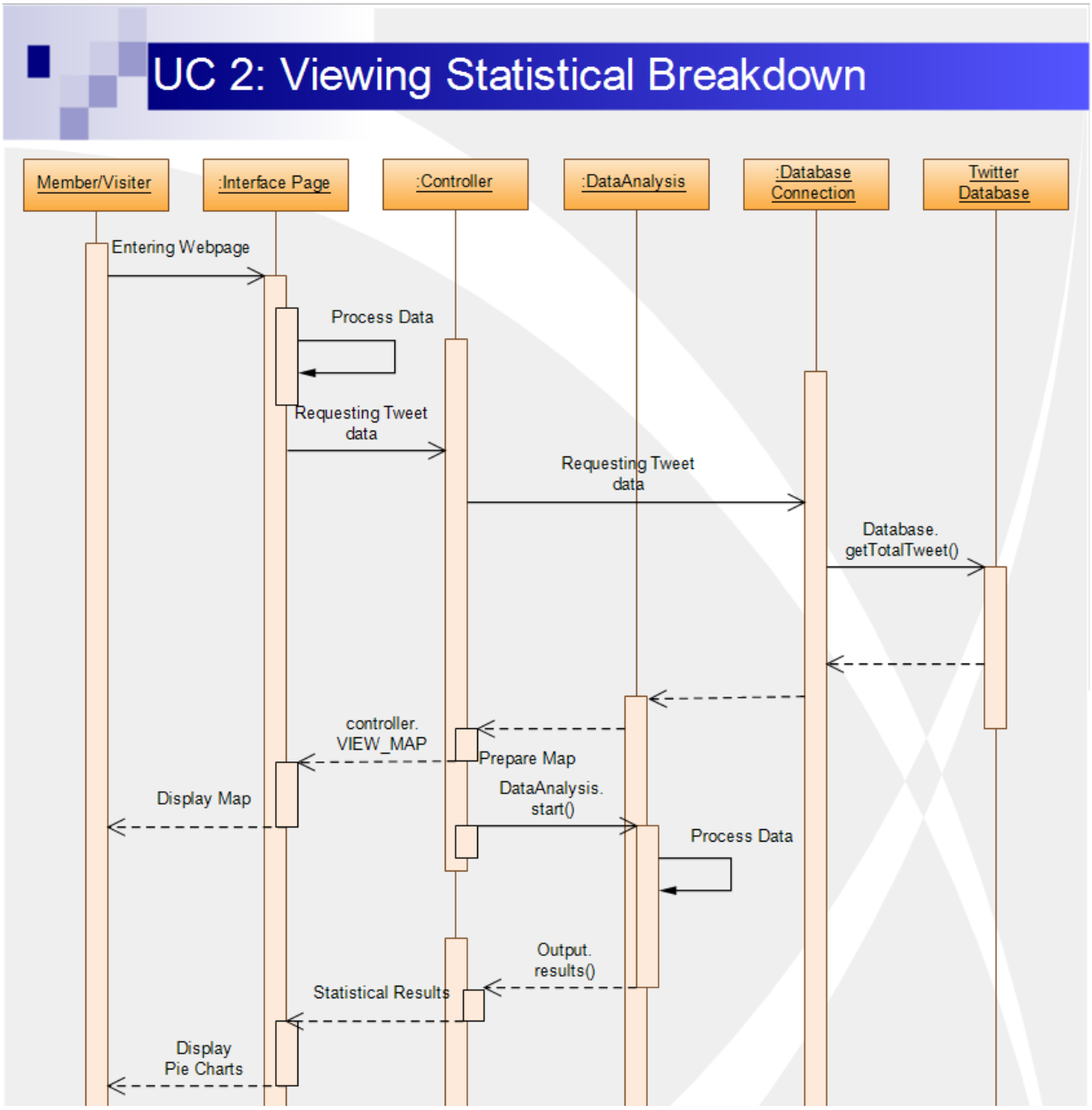


Figure 16: Use Case 2: View Statistical Breakdown

Use Case 2 is designed with the intention of giving the user the ability to view statisitcal breakdown data. Graphical data here refers to the breakdown of tweets by contiguous regions of the United States. The interaction diagram displays the process the system needs to go through in order to handle the users input and correctly display the output; it waits for a user request and then generates the correct chart type off of that. The user needs to navigate to their index page to see the analysis in a more direct fashion. The user will see pie charts that split the tweets into four regions of the United States, and those four regions are further broken down into the later 50 states that make them up.

Following is the description about how we collected tweet data and categorize them based on the location:

All of our tweets are pulled corresponding to a set of hashtags. Most of the tweets that we collected don't have location data, so the latitude and longitude values are 0 for them. Only a small portion of the tweets that we collected have location information provided with latitude and longitude. Ideally, we can use reverse geo coding to obtain the exact address for each tweet that has latitude and longitude values. However, Google map service for geo coding has special limitation of the number of requests we can make in one day. Our massive twitter data needs more than Google's limitation. Sticking with less cost policy for our class project, we decided to use an alternative way: the bounding box idea for each state. Considering the difficulty to use bounding box for each city, we divided the US tweets for different state. To define a bounding box for one state, we only need to know the minimum latitude, minimum longitude, maximum latitude, and maximum longitude that the state covers. Therefore, we defined these four extreme values for the bounding box of each state. All the tweet locations that fall into a box will be marked as tweets from that corresponding state. Since bounding boxes are rectangular, they wouldn't fit the state boundary perfectly. This would cause some mistakes in the state determination. However, this is the second best way we can find besides using the reverse geo coding.

We obtain the extreme values of latitude and longitude for each state online. Then all of these data are included in the program to estimate the state of each tweet location. In other words, each tweet with location has to go through a loop to determine which state it belongs to. See Figure 1 for an example of the bounding box for Arkansas. This is plotted with one of our bounding box data. Four makers indicate four corners of the bounding box. We can see from the figure that one of the marker lands on Mississippi.

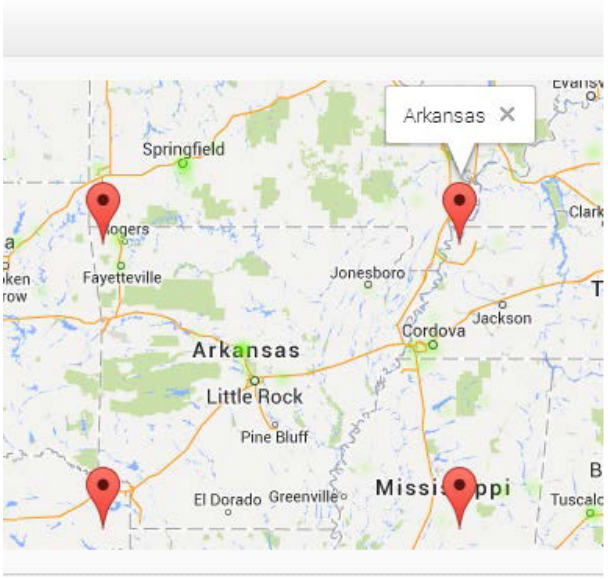


Figure 17: Example of a bounding box

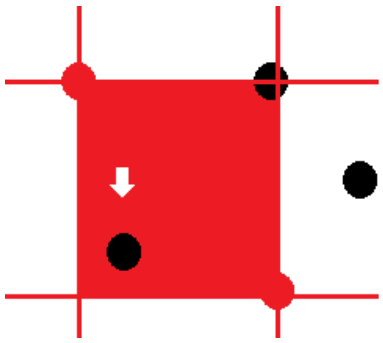
We couldn't design the filter to have a set of hashtags and a specific location during our data mining. In other words, we can choose to pull all the tweets with a set of hashtags, but we have no control on where these tweets should be from. Alternatively, we can choose to pull all the tweets on a specific location (for example "New Jersey"), but we cannot set up the hashtag requirement at the same time. Knowing that twitter API doesnt allow filtering of tweets with more than one specification, we decided to pull data with hashtags so that we only extract useful data from twitter site. This leaves us having no control in tweets location. Therefore, we got the tweets from other countries as well. Using the bounding box illustrated above, we extract out all the tweets from US.

As for the data, the period collected initially was over a one month period starting near the end of October. At the time, we had believed that the Twitter filters applied by the API were working correctly and didnt check that the location filter and hashtag filter were properly working. The MySQL database had been set up but when it was reviewed no outstanding errors were seen. It was only when we begin to do the marker maps and filling in with tweet data text did we realize that the data was horrifically noisy; we had gathered all tweets from the US and added onto that tweets filtered by our specific health related hashtags. So the problem was that we did not understand specifically how Twitter applies its filters; e.g. this was a programming error that caused the database to become full of junk tweets. The database had to be flushed entirely. And then the modifiers had to be played around with after that to make sure the tweets were being filtered correctly. All told, the demo represented tweets gathered over a period from 11/29/13 to 12/06/13 one week worth of tweets.

Twitter DOES allow you apply more than one filter to the data. They have several different predicate parameters for querying the data. To begin, Twitter data is obtained by making an HTTP POST (as I am sure you are familiar, this is a standard HTTP protocol for web servers to make a request for data) for the information. We can select the presentation of the material: XML or JSON. We selected JSON because were using Javascript on the

server side to data processing and rendering. The data, when queried from our DB, would be sent as a JSON to be parsed by Javascript later on. As for the query structure, an example would be as the one they supply in their API code:
https://stream.twitter.com/1.1/statuses/filter.json?delimited=length&track=twitterapi:
This is what we are POSTing to. Everything after the filter.json? are parameters that we can set ourselves and then append onto the URL with '&' symbols. The parameters are:

- Follow
  - Follow is a comma separated set of user IDs. (So follow=twitterapi to find @twitterapi tweets). The server will return all tweets for the specified user IDs containing:
    - User generated tweets
    - Tweets retweeted by the user
    - Replies to any tweet the user made
    - Retweets of the users tweets by other people
  - It does not have:
    - Tweets with the users name in it
    - Tweets from users with privacy centric settings (e.g. private users)
- Track
  - These are the list of keywords to track (in other words, the hashtags). This is also a comma separated list of characters. We are not able to do exact searching(e.g. like typing "donuts krispy Kreme" into Google with quotes to ensure the results contain these words). We can't exactly delimit by hashtag either, because the streaming API for this parameter when we search for "twitter" returns any instance of it; TWITTER, twitter, "Twitter", #twitter, twitter, etc. So even if we search for "#twitter" we're still going to introduce noise that isnt related to our hashtag. We can search for multiple hashtags with this; it's the primary parameter for our search.
- Locations
  - This is a CSV list as well of parameters. The Twitter API parses in sets of twos to look at the latitudes and longitudes. The API takes four GPS coordinates (two latitudes, two longitudes) and uses those to create a "bounding box" as shown below:



  - The bounding box has the two GPS pairs as red dots in the corners. We capture the black point inside the red filled box and ignore everything outside of it.
  - Bounding box is NOT used in conjunction with other filters. Using location and track together (say location is set to New York and track is looking at #twitter, then we would get all tweets related to New York and all tweets related to twitter. So you'll pull about 1,000 tweets from NY about things totally unrelated to #twitter and then youll pull all tweets worldwide as well that only deal with #twitter.

- Delimited
  - This parameter lets you set how long you want the tweet to be that you're searching for.

- Stall warnings
  - This is a logical yes or no that just sets whether or not you want stall warning set. This sends messages back to you about whether or not you're about to be disconnected. People using the streaming API have their bandwidth limited. Since we are using firehose on the streaming API, we grab as many tweets as we can before Twitter truncates our connection. Ideally, we would keep it open forever but at some point, since we are not business customers, we cannot make heavy demands on their servers for very long. Connections can be unlimited but the bandwidth used by it is capped; a status warning would send typical warning back to you about how much percent you are towards getting cut off so you can adjust your stream requests on the server end.

Since we are running a Linux server on our host, we have access to what is called a cron job. A cron job is just a script that is scheduled by the server to occur at periodic intervals by invoking the cron command on the PHP script. So the task can be scheduled by our web host to run two times an hour per any job at a specified time (xx:05 & xx:15, for example so twice an hour at 5 minutes after and 15 minutes after). However, we can schedule multiple cron jobs to occur per hour. So this means the tweet retrieval script can be run once a minute if we schedule 30 jobs that occur at (xx:00, xx:01) and (xx:02,xx:03) et cetera. Our setup is two cron jobs to do the tweet retrieval that run at (xx:00,xx:15) and (xx:30,xx:45). More can be scheduled but it didnt seem worth the benefit because we can retrieve tweets we already have before; it is a delicate balance.

The alternative was to keep the stream open as long as possible by having the server execute the tweet retrieval script in the back ground. Designating a script with nohup when running it in Linux tells the server to continue running the script even if the user who called it is disconnected from it. This seemed very ideal for us because that means we could get tweets forever without impunity. However, two issues arose:

- The bandwidth limiting from Twitter. We can keep the stream open as long as we want but at some point Twitter itself will cut us off anyway. We didnt exactly experience this because of the second reason.

- We were running off of shared hosting from our web host, GoDaddy. Shared hosting is an inexpensive hosting service where we share the server time and space with other user accounts on the website. Running a script with nohup on shared hosting means that youre stealing resources away from everyone else. A nohup will run for a little whiel (about 7 minutes I believe) on GoDaddys shared hosting before they step in and terminate the script forcibly.

So these two reasons are why we had to resort to cron jobs to pull tweets. This data was collected at these discrete time intervals. So it's not a continuous open socket of data retrieval; the data is retrieved for about 3 5 minutes at a time before the connection is severed. So we retrieve tweets for 3 5 minutes every 15 minutes or so. So there are gaps where there are no tweets collected at all until the next time marker for another scheduled cron job.

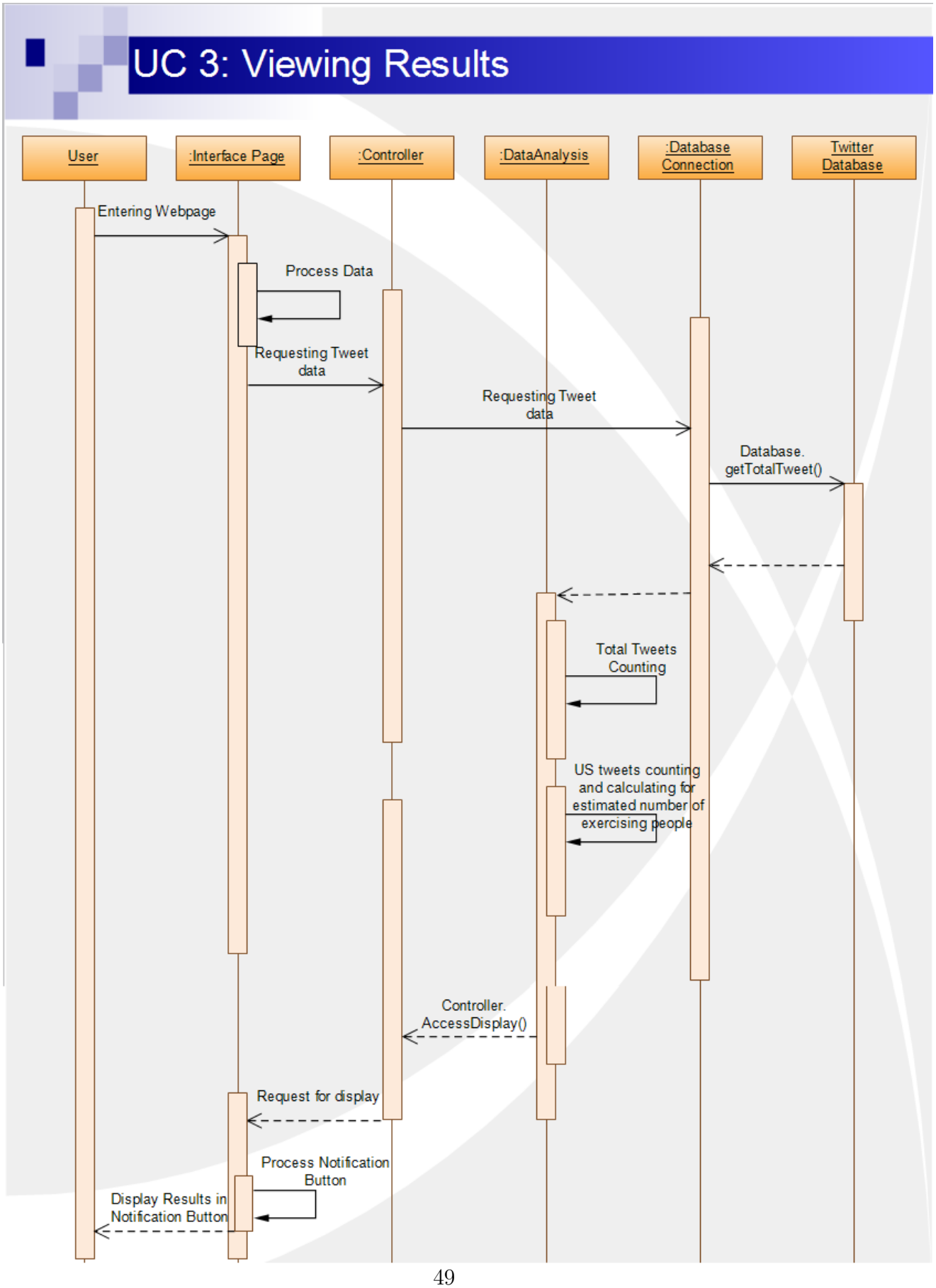


Figure 18: Use Case 3: View Results

Use Case 3 is designed with the intention of giving the user the ability to view the results the system has to offer on its data processing. Results here refers to displaying how many tweets have been aggregated by the system, how many tweets have a proper geolocation, how many tweets are from the United States, and finally how many tweets are in each state. The interaction diagram displays the process the system needs to go through in order to handle the user's input and correctly display the output; it waits for a user request and then generates the correct chart type off of that. The user needs to navigate to their index page to see the analysis in a more direct fashion. The user will see pie charts that split the tweets into four regions of the United States, and those four regions are further broken down into the later 50 states that make them up.

For the result displaying, we also added a statistical analysis graph counting the number of tweets produced over 24 hours of day. The tweets we obtained also include the time when a tweet is posted. This gives us another approach to analyze the data. We divided the tweets into four divisions based on their location: northeast, midwest, south, and west. We processed the data for each location division. For example, we need to analyze the tweets from northeast. In the program, we have a loop to go through each tweet. For each tweet, we extract the time string to determine which hour the tweet is posted. Then we count the number of tweets for each hour.

We plotted "tweet count vs hour-in-day" curves for four US regions. The curves change when we have larger amount of tweets. We constantly pulling data from twitter and our website automatically updates with the most recent data. From the curves we showed in demo 2, west seemed to tweet about exercise at about 6pm after work. Figure 2 shows the current distribution of tweets over 24 hours of day. People from west (blue curve) tweet more about exercise in 7pm judging from the curve peak at 17th hour of days. As we can see from current curves, people in south tweets most at around 10am and 5pm judging from the two peaks of the curve. The curves generally becomes more flat comparing to what we had in the demo day. We can still see the hours when people tweet more from the peaks of curves. The red curve shows the total US people tweeting activity. People tweet more during the daytime from 9am to 10pm than other time periods such as 12am to 6am.

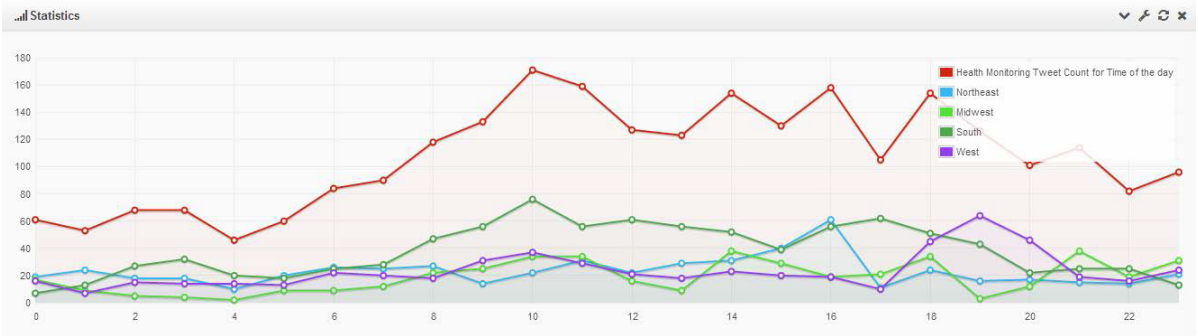


Figure 19: Statistical Graph

It is possible that your results are affected by a small sample size We only have a small number of users collected for a given community, so their individual habits can become prominent, especially if the time they tweet at during a given day is presumably constant. We only collect tweets 3 5 minutes every 15 minutes so if users tweet at the same time every day then we could be biasing our data with that information.

We have about 300k users from whom we pulled data from over the 1.5 weeks. Not all of these users are relevant; the problem is many do not have location enabled on their devices and of the ones that do not all of them reside in the United States. So, as the problem before with gathering many useless tweets, we have many tweets from what we can consider to be useless users. The interface should be updated with the amount of users who are generating useful tweets as well os we can obtain an idea of how large a subset we are dealing with as far as people who tweet and people who care about their health.

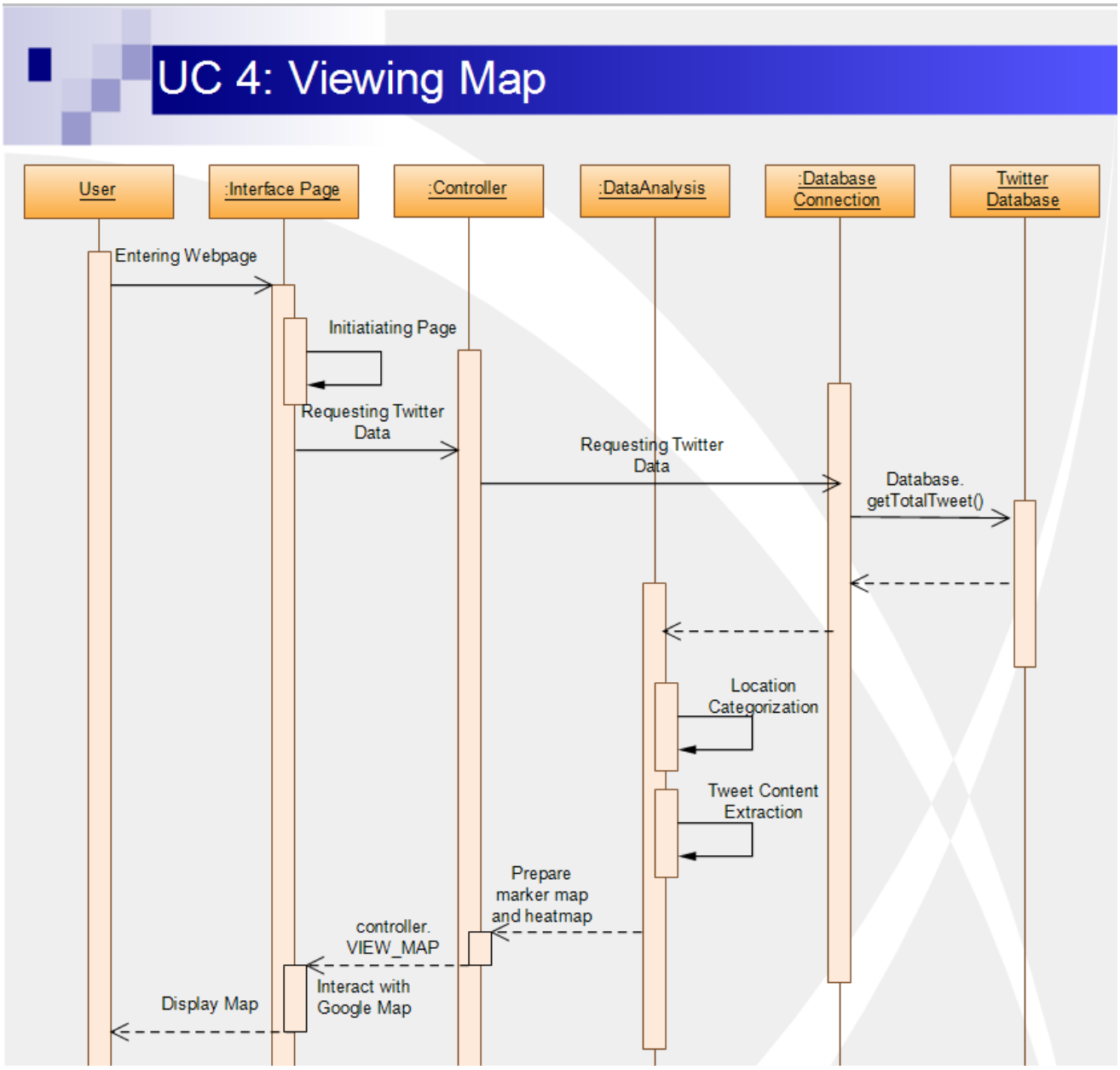


Figure 20: Use Case 4: Veiw Map

Use Case 4 is designed for visualization of heatmap and marker map using Google map service. The marker map contains clickable markers placed in tweets' locations for displaying health-related tweet content. The interaction diagram shows how it gets implemented in our system. This visualization requires the connection with Twitter database and the Google map service. Following explains in detail about the data filtering and location categorization:

For the data filtering, we only focused on the "track" parameter. We only really had two options as far as we could see for searching for data:

- Filter by location and filter by hashtags. This means we could pull ALL OF THE TWEETS from the United States along with ALL OF THE TWEETS worldwide

about healthcare. The problem with this is were collecting huge amounts of junk data; theres millions of tweets per hour in the United States. The percentage of those that would be related to health must be astronomically low.

- Filter only by hashtag. This means we would pull tweets worldwide about relevant subject material but we wouldnt be able to restrict it by location. As such, we would end up with tweets that have their GPS coordinates hidden (as adjusted by the users privacy settings) along with tweets that are outside the United States. This seemed like the best solution because it would reduce the number of tweets and the noise while still keeping the material relevant. As it would turn out, only a small percentage of the tweets we pulled would be relevant to the US since the majority of them have their location hidden.

As for explicit filtering, we obtained many tweets. However, in our SQL table, we have two entries that we can use to filter the data: geo_lat and geo_long (when we get the JSON file of a tweet from Twitter it contains latitude and longitude coordinates. We sort the data into our tables like that with this name). We can construct an easy SQL query to request Tweet data such that we are only pulling Tweets from our database into our web page that has latitude and longitude coordinates like this type of query:

- $latquery = "SELECT geo_lat FROM tweets WHERE geo_lat!=0 ORDER BY geo_long";
- $longquery = "SELECT geo_long FROM tweets WHERE geo_long!=0 ORDER BY geo_long";
- $textquery = "SELECT tweet_text FROM tweets WHERE geo_lat !=0 ORDER BY geo_long";

Then just execute the query via PHP commands. On our server end, we implement the tweet filtering via bounding box through JavaScript as explained in another answer.

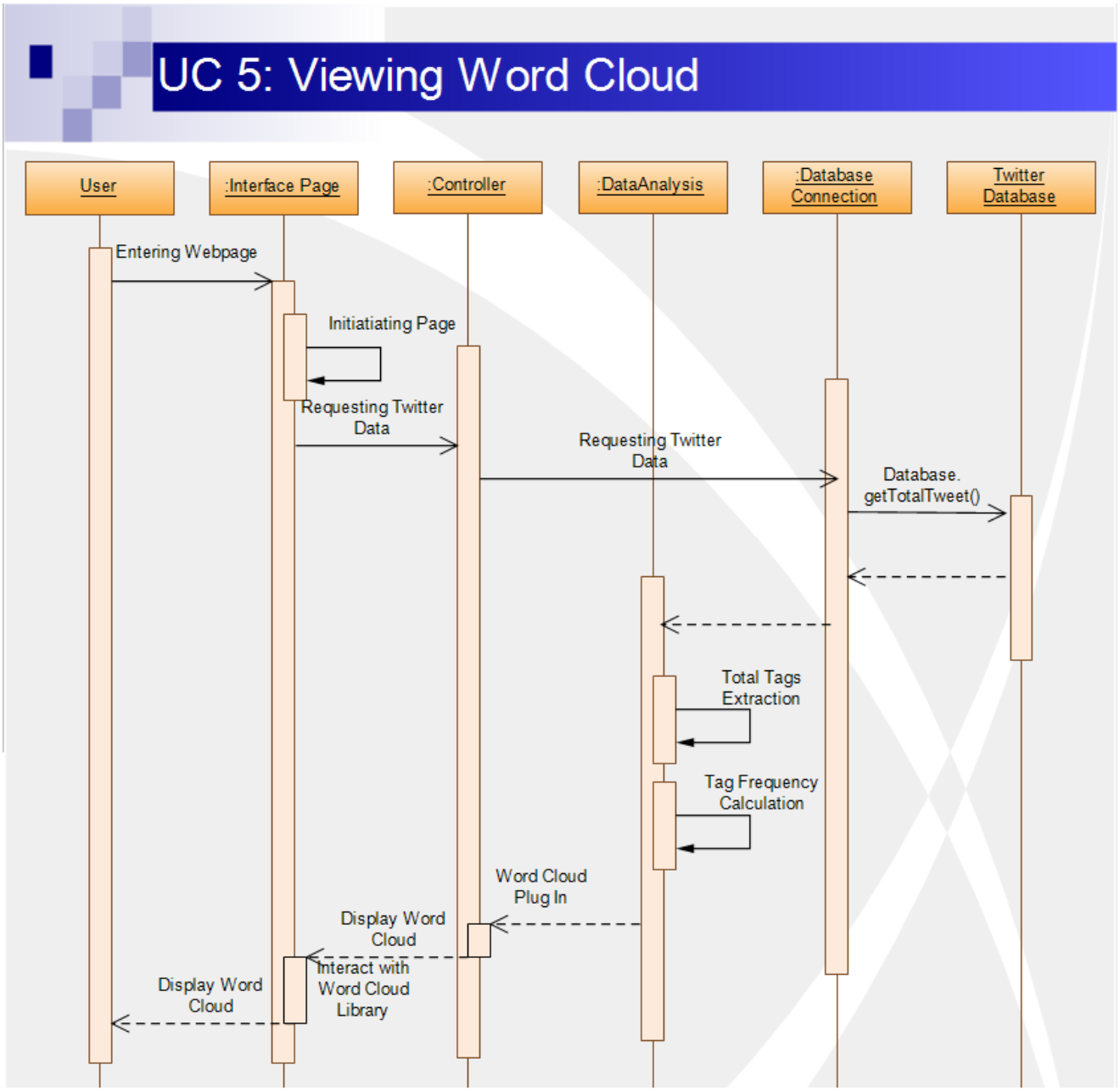


Figure 21: Use Case 5: View Word Cloud

Use Case 5 is designed to visualize the popularity of each hashtag based on the frequency of appearance in tweets. The frequency of a hashtag comparing to others are reflected with the size of the word in the word cloud when it is in focus. The interaction diagram shows the general data process of word cloud implementation. Following shows the hashtags for the word cloud.

'#run'	'#running'	'#gym'	'#jog'	'#jogging'
'#jogger'	'#marsic'	'#exercise'	'#exercising'	'#exercises'
'#fitness'	'#fit'	'#fitfam'	'#seenonmyrun'	'#fitnessfriday',
'#fitforlife'	'#mefirst'	'#gymtime'	'#healthy'	'#bodybuilding'
'#chest'	'#workout'	'#getfit'	'#active'	'#healthychoices'
'#diet'	'#cardio'	'#strong'	'#training'	'#fitnessaddict'
'#fitspo'	'#instahealth'	'#trailrunning'	'#trailrunner'	'#trailrun'
'#fitspiration'	'#fitnessmotivation'	'#gettingfit'	'#dreambody'	'#fitnessgoal'
'#resultssofar'	'#transformation'	'#goal'	'#dontgiveup'	'#weightloss'
'#morningrun'	'#workoutsoicaneat'	'#TFLers'	'#tflers'	'#gymlife'
'#trainhard'	'#grow'	'#bulk'	'#squat'	'#squats'
'#instafitness'	'#ripped'	'#swole'	'#muscle'	'#shredded'
'#pushup'	'#pushups'	'#sweat'	'#grind'	'#fitnessgear'
'#pushpullgrind'	'#bigbench'	'#fitgram'	'#pullup'	'#pullups'
'#gymrats'	'#eattogrow'	'#physique'	'#nikeplus'	'#nike+'
'#fitnessmodel'	'#fitnessaddict'	'#trainer'	'#yoga'	'#ironaddicts'
'#lifting'	'#addictedtoiron'	'#bootcamp'	'#workout'	'#strengthtraining'
'#smashfit'	'#squash'	'#swimming'	'#biking'	'#cycling'
'#losing weight'	'#keepfit'			

Table 9: Table of Used Hashtags

These tweets were selected by looking at the hashtags correlated with tweets about fitness. Since we are not limited by the number of hashtags, we grabbed any that seemed relevant. Problematic hashtags are ones that seemed good but ended up generating junk data. #health always seemed to correlate to news results or current events; e.g. bioterrorism. Never saw any tweets with #health that had anything to do with our study. #train was also similar; it generated results about trains and accidents that occurred recently or people complaining about being late for the train. So this is an issue with context.

As for when we do the search, we get a list of hashtags associated with the tweet every hashtag the user used. So if we don't know what hashtags to look for, we only need a few health related ones (e.g. fitness) and then we would get tweets from users that are relevant with #fitness and would contain many more hashtags with it that were likely relevant because the users tend to group their tags in this way (heuristically). So one can increase the sample space of where to search for by increasing their tag number, of course at some point increasing hashtags in this way must result in no returns at all. We imagine the curve would be something like a decaying exponential that rises to a constant value and stops or a sort of log(t) graph (again, heuristically). So the # of hashtags is generally greater in our data base than the # of tweets themselves and this makes sense (200k hashtags for 10k tweets, so about 20 hashtags on average per tweet).

10 Class Diagram and Interface Specification

In this section, we describe the framework of our application.
We originally intended for users to be integrated into the system, but after final review it wasn't possible. However, this design could be implemented later as well with what we have finished to fully integrate users into the system. So we elected not to make changes to preserve its functionality.

10.1 Class Diagram

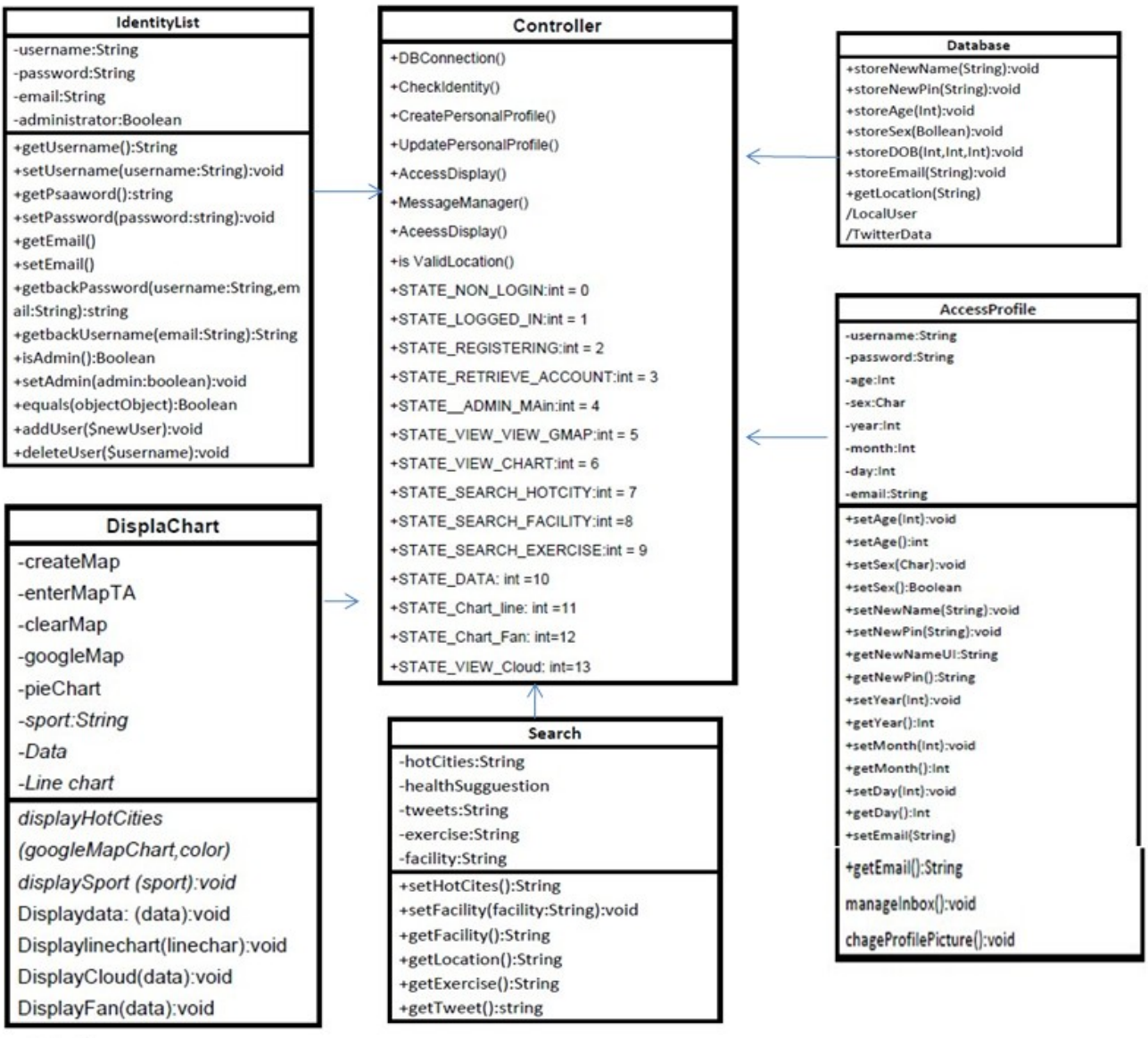


Figure 22: Class Diagram

The figure illustrates most of classes and their interaction in this software-to-be. In this project, we mainly have five classes and two derived class LocalUser and TwitterData. Every time user reaches the user interface and makes a request, then the controller will pass data retrieve request to the database. In response, database would send requested data package to the controller. The controller would then call relevant functions with data package to meet the user request.

10.2 Data Types and Operation Signature

10.2.1 Identity List

The first class, IdentityList, contains all of the users personal information inside the following variables:

- Username
  - String variable corresponding to the users username.
- Password
  - String variable corresponding to users password.
- Email
  - String variable corresponding to users email.
- Administrator
  - Boolean variable indicating whether or not a user is an administrator (TRUE) or a normal user (FALSE).

The functions of this class are listed below. These include various set and get functions for class encapsulation along with functionality for the administrator to manage a given users account information.

- getUsername()
  - Typical get function. Is used when the system needs to retrieve a username from an associated instance of the IdentityList object. Returns the current value of the username variable.
- setUsername($username)
  - Typical set function. It is used when the system needs to change/specify a username for an associated instance of the IdentityList object. This would be called when the user is registering or trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the username variable and forwards the change to the database.
- getPassword()

  - Typical get function. Is used when the system needs to retrieve a password from an associated instance of the IdentityList object. Returns the current value of the password variable.

- setPassword($password)
  - Typical set function. It is used when the system needs to change/specify a password for an associated instance of the IdentityList object. This would be called when the user is registering or trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the password variable and forwards the change to the database.

- getEmail()
  - Typical get function. Is used when the system needs to retrieve an email from an associated instance of the IdentityList object. Returns the current value of the email variable.

- setEmail()
  - Typical set function. It is used when the system needs to change/specify an email for an associated instance of the IdentityList object. This would be called when the user is registering or trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the email variable and forwards the change to the database.

- isAdmin()
  - This is called by the system in the event that a user attempts to access Administrator level privileges. Returns the current value of the administrator variable.

- setAdmin(admin:boolean)
  - Typical set function. It is used when the system needs to change/specify Administrator privileges for an associated instance of the IdentityList object. This would be called when the system or another Administrator is changing user privileges. Calling this function updates the value of the administrator variable and forwards the change to the database.

- addUser($newUser)
  - This function is called when a new user is registering for the system. The $newUser reference is presumed to be an IdentityList object whose set functions were called after the registration button was pushed and populated with values from the form fields. The new user is inserted into the database at the end of the function call.

- deleteUser($username)

  - This function is called when an administrator is attempting to purge a user account from the database. The function takes a String variable and loops through the database until it finds an IdentityList with a matching username. Once found, the IdentityList is removed from the database.

- equals(object:Object)
  - Superclass method of the Java Object class. This is overridden and returns TRUE if two variables match each other all classes have this functionality (String included).

10.2.2 DisplayChart

The DisplayChart class implements the main functionality for the chart and map user interface elements. It contains the following variables:

- googleMapChart
  - This is a MapFragment variable that is stored directly inside the class (MapFragment is coming from the Google API).

- Color
  - This is a String variable that holds the value of the color the user wants the map markers to display.

The function of this class is listed below.

- displayHotCities ($googleMapChart,$color)
  - The user will input where they want to look and what color they want the markers on their map to be. A MapFragment is then dynamically generated/updated to match their preferences and passed to this displayHotCities function. This will propagate through the system to the output.

10.2.3 AccessProfile

When dealing with the use case where the user needs to modify their personal information, an additional class needed to be introduced to handle the information outside of what is needed for simple registration (e.g. name and email). As such, we have this class: AccessProfile. These include various set and get functions for class encapsulation. AccessProfile exists as a class since it needs to be instantiated for more than one user who accesses their profiles at a time. The variables for the class are listed below:

- Username
  - String variable corresponding to the users username.

- Password

  - String variable corresponding to users password.

- Email
  - String variable corresponding to users email.
- Age
  - Integer variable corresponding to the users age.
- Year
  - Integer variable corresponding to the year the user was born.
- Month
  - Integer variable corresponding to the month the user was born.
- Sex
  - Boolean variable corresponding to gender. (FALSE) = Female and (TRUE) = Male.
- Day
  - Integer variable corresponding to the day the user was born (this is day of the month, not day of the year).

The functions for this class are outlined below.

- setAge ($age):
  - Typical set function. It is used when the system needs to change/specify the age for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases) or when the system is attempting automatic updates once the users birthday has been reached. Calling this function updates the value of the age variable and forwards the change to the database.
- getAge ():
  - Typical get function. Is used when the system needs to retrieve an age from an associated instance of the object. Returns the current value of the age variable.
- setSex ($sex):
  - Typical set function. It is used when the system needs to change/specify the sex for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the sex variable and forwards the change to the database.

- getSex ()
  - Typical get function. Is used when the system needs to retrieve a sex from an associated instance of the object. Returns the current value of the sex variable.
- setNewName ($name):
  - Typical set function. It is used when the system needs to change/specify the name for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the username variable and forwards the change to the database.
- getNewName ():
  - Typical get function. Is used when the system needs to retrieve a sex from an associated instance of the object. Returns the current value of the username variable.
- setNewPin ($pass):
  - Typical set function. It is used when the system needs to change/specify the password for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the password variable and forwards the change to the database.
- getNewPin ():
  - Typical get function. Is used when the system needs to retrieve a password from an associated instance of the object. Returns the current value of the password variable.
- setYear ($year):
  - Typical set function. It is used when the system needs to change/specify the year for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the year variable and forwards the change to the database.
- setMonth ($month)
  - Typical set function. It is used when the system needs to change/specify the month for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the month variable and forwards the change to the database.

- setDay ($day)
  - Typical set function. It is used when the system needs to change/specify the day for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the day variable and forwards the change to the database.
- getYear ():
  - Typical get function. Is used when the system needs to retrieve a year from an associated instance of the object. Returns the current value of the year variable.
- getMonth()
  - Typical get function. Is used when the system needs to retrieve a month from an associated instance of the object. Returns the current value of the month variable.
- getDay()
  - Typical get function. Is used when the system needs to retrieve a day from an associated instance of the object. Returns the current value of the day variable.
- setEmail ($email):
  - Typical set function. It is used when the system needs to change/specify the email for an associated instance of the class. This would be called when the user trying to change their personal information (as detailed in the use cases). Calling this function updates the value of the email variable and forwards the change to the database.
- getEmail ():
  - Typical get function. Is used when the system needs to retrieve an email from an associated instance of the object. Returns the current value of the email variable.
- manageFriendList ():
  - This operation allows a user to manage his own friend list. It prompts the user with his/her friend list and gives the user the freedom to add or delete a friend.
- manageInbox ():
  - This operation prompts the users inbox and shows his messages. A user can delete or save messages.
- changeProfilePicture ():
  - This would allow a user to change his picture on his/her personal profile.

10.2.4 Database

The Database class defines operations connected with database. This class is in charge of storing and updating users personal information, as well as getting data for other classes. There are 5 operations and 2 derived class.

- storeNewName ($name):
  - This function would be called internally within any setName function and would update an associated value (e.g. username) within in the DB for that update.
- storeNewPin ($pass):
  - This function would be called internally within any setNewPin function and would update an associated value (e.g. password) within in the DB for that update.
- storeAge (Int)
  - This function would be called internally within any setAge function and would update an associated value (e.g. age) within in the DB for that update.
- storeSex ($char)
  - This function would be called internally within any setSex function and would update an associated value (e.g. sex) within in the DB for that update.
- storeDOB ($year, $month, $day):
  - This function would be called internally within any call of setMonth/setDay/setYear function and would update an associated value (e.g. day, month, year) within in the DB for that update.
- storeEmail ($email):
  - This function would be called internally within any setEmail function and would update an associated value (e.g. email) within in the DB for that update.

As shown in Figure 3.2, class Database has two derived classes: LocalUser and TwitterData. These two derived classes contain lists of data for other classes.

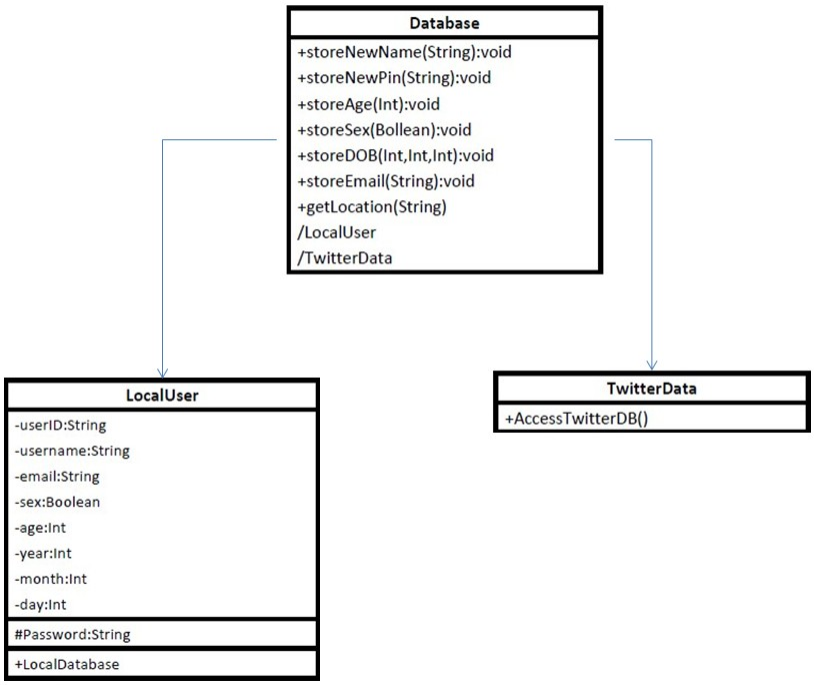


Figure 23: Logic Diagram of the VGA Controller Block

10.2.5 LocalUser

LocalUser is a derived class that represents a users information inside of the database. Most of the private attributes in this class are personal information that has been described in previous sections.

- Friendlist
  - A String pointer that points to the beginning of a linked list of userIDs the users friends.
- Password:
  - A String variable that is a data member of class LocalUser. Password variable as seen earlier.
- LocalDatabase ():
  - This is an operation that grants access to the system when it makes a call to open a portal between the database and the website.

10.2.6 TwitterData

TwitterData is a derived class used when requesting access to the Twitter Database.

The functions of this class are below.

- AccessTwitterDB ():
  - This operation is used whenever we need to access the Twitter Database and obtain data from it. Obtained data will be used in other classes and operations.

10.2.7 Search

This class is meant to implement the functionality behind the searching function in the application. The data stored in this class is:

- hotCities
  - This is a String variable that contains a list of all the hot cities requested in a query.
- healthSuggestion
  - This is an (as-of-yet) unimplemented class that would contain a series of suggestions on how to improve the users health.
- Tweets
  - This is a String variable that holds the Tweet query that is typed in by the user.
- Exercise
  - This is a String variable that holds the exercise query that is typed in by the user.
- Facility
  - This is a String variable that holds the facility query that is typed in by the user.

The class methods are described below.

- setHotCities($city):
  - Typical set function. Is called when the user begins typing their query for a city and presses the search button. The variable in the class is what gets set.
- getHotCities():
  - Typical get function. Is used when the system needs to retrieve a Hot Cities from search results and send back to the screen.
- setFacility($city)
  - Typical set function. Is called when the user begins typing their query for a facility and presses the search button. The variable in the class is what gets set.
- getFacility():

  - Typical get function. Is used when the system needs to retrieve facilities from search results and send back to the screen.

- setExercise($exercise):
  - Typical set function. Is called when the user begins typing their query for an exercise and presses the search button. The variable in the class is what gets set.

- getExercise():
  - Typical get function. Is used when the system needs to retrieve exercises from search results and send back to the screen.

- setTweets($tweet):
  - Typical set function. Is called when the user begins typing their query for a tweet and presses the search button. The variable in the class is what gets set.

- getTweet():
  - Typical get function. Is used when the system needs to retrieve tweets from search results and send back to the screen.

10.2.8 SendMessage

This class implements the functionality described in previous use cases for when users want to communicate directly with each other through the website. The class variables are as below:

- userID
  - A String variable containing the userID the user wants to message.

- Message
  - A String variable containing the message the user wants to send to the user specified by userID.

The class methods are explained below.

- findFriend($userID):
  - This function will loop through the user database until it finds a user that matches the userID (effectively a series of get calls).

- addFriend($userID):
  - Takes the userID and updates the String pointer in a users database to include this new ID as well.

- deleteFriend($userID):

  - Takes the userID and updates the String pointed in a users database to remove the ID associated with the variable.

- writeMessage($message):
  - It allows user to edit text content he/she wants to send as a message to friends. If the content is legal, it returns 1 and would calls the function messageFriend($userID), otherwise, it returns 0 and requests a re-enter to user.

- messageFriend($userID):
  - It works as a communicator in this class. It is called by writeMessage($message) functions and sends the edited message to the target user ID. It also utilizes the findFriend($userID) function to locate the correct user ID.

10.2.9 Controller

This class works as a central controller and communicator in the system-to-be. It contains seven derived functions : DBConnection(), CheckIdentity(), CreatePersonalProfile(), UpdatePersonalProfile(), AccessPersonalProfile(), MessageManager() and AccessDisplay(). Each function is linked to the other classes to perform user requests. It also contains ten status of the current system. This class is essential to system performance; we would get nowhere without it.

- DBConnection():
  - It establishes a connection to the database for either stored local user profile or Tweet data.

- CheckIdentity():
  - It links to the IdentityList class when users try to login or edit profile.

- CreatePersonalProfile():
  - It links to the AccessProfile class to create personal profile when a new user registers for the system. It also links to Database class to store the newly created data.

- UpdatePersonalProfile():
  - It provides a link to both of the AccessProfile and Database class when the logged in user attempts to edit his/her profile.

- AccessPersonalProfile():
  - It links to the AccessProfile class for users to gain access to their profile.

- MessageManager():

- It links to the SendMessage class to send messages between different users.

- AccessDisplay():
  - It links to the DisplayChart class to display different types of charts for users.

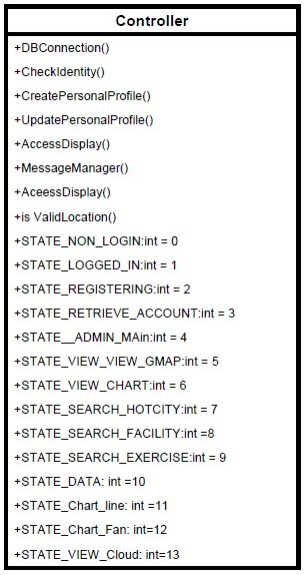


Figure 24: Logic Diagram of the VGA Controller Block

10.3 Traceability Matrix

Domain Concept	UC1	UC2	UC3	UC4	UC5
Controller	x	x	x	x	x
Interface	x	x	x	x	x
Data Analysis		x	x	x	x
Communicator	x	x	x	x	x
DB Connection	x	x	x	x	x

Table 10: Traceability Matrix

11 System Architecture and System Design

11.1 Architectural Styles

In our software, there are three abstraction layers being implemented in our design:

- User Interface

  - This is top level of the software system and is the only part the user is aware of. It displays all the relevant information that the user needs when searching the site, inputting queries, et cetera. This tier communicates with other tiers by sending results to the browser and the other branches of the network. A website forms the front end and it can be accessed by any computer. Information is displayed in a static form and the user isnt given any ability to directly modify the Database (except by initiating process management functions; e.g. changing password).

- Process Management
  - This middle level forms the core functionality behind the user interface. It controls application functionality by performing detailed processing with related function calls (as seen in the use cases). This tier is concerned with system functioning and processing functionality, e.g. searching for data, recording updated information, retrieving login information and related tasks.

- Database
  - Database in this tier is kept independent of application servers and user interface. The database management system on the database server contains the computer data storage logic. When a request is sent to this tier, database will look up the desired data.

Our system is a web based application which needs to serve a large amount of users. Much of the functionality weve discussed so far depends on database interactions and queries. We determined that a system like our software needs Browser/Server architecture so that it can set up a communication pathway between the user side and the data side.

11.1.1 Browser/Server Structure and 2-Tier Architecture

Browser/Server (B/S) structure is an extension of Client/Server (C/S) architecture. In such a structure, the user interface is through a web browser (Chrome, Firefox, Internet Explorer, etc.), rather than installing the application in a Client/Server structure. This greatly simplifies the client computers load, reduces system maintenance, and reduces upgrade costs and the workload and the overall cost of the user (TCO). It is differentiated from C/S structures 2-tier architecture, B/S structure usually needs a middleware between the front end and the backend, forming a 3-Tier Structure.

11.1.2 Tier Architecture

This is well suited to separate the roles of three components of the system: the presentation tier, the application tier and the data tier. And each component is a tier that can be located on a physically separate computer. They generally use platform specific methods for communication instead of a message-based approach. Different from 2-tier model, the 3-tier architecture describes the separation of functionality into segments, which independently keeps the process management and model logic delineated. Additionally, 3-tier architecture allows any one of the three tiers to be upgraded or replaced independently.

Compared with the 2-tier B/S model, this 3-tier architecture style will improve system reliability and flexibility. The main benefits of the 3-tier architectural style are:

- Maintainability
  - Because each tier is independent of the other tiers, updates or changes can be carried out without affecting the application as a whole.
- Scalability
  - Because tiers are based on the deployment of layers, scaling out an application is reasonably straightforward.
- Flexibility
  - Because each tier can be managed or scaled independently, flexibility is increased.
- Availability
  - Applications can exploit the modular architecture of enabling systems using easily scalable components, which increases availability.

11.2 Identifying Subsystems

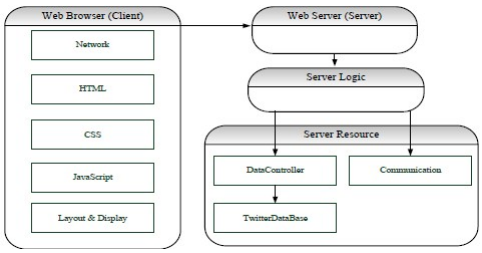


Figure 25: Logic Diagram of the VGA Controller Block

In this system, there are two subsystems. One is the client side - the web browser, the other side is server - web server. The client package mainly refers to the website framework, and it contains the building structure of the user interface. For the server side, when the user uses sends a request to the web server, the server would response through processing it in its logic package. The logic unit would analyze it and further pass it to the server resource package. This package is responsible for retrieving data from local Twitter database and internal communication.

11.3 Mapping Subsystems to Hardware

As shown in Figure 4.1, the subsystem can be mapped into the following hardware component easily. The Web Browser package are allocated in clients PC, and the user would use this to access the application user interface. The Web Server as well as Server Logic package is allocated in the server. They would use this to appropriately analyze and process the user requests. The Server Resource package is allocated in the central server.

11.4 Network Protocols

There are many network protocols such as FTP (File Transfer Protocol), HTTP (Hyper Text Transfer Protocol) and SSH (Secure Shell). In this system, a user uses the website to log into his/her personal account and access the software user interface. Since we have a web design, we need to use HTTP so users can navigate to the website from their personal computer.

11.5 Global Control Flow

For execution order in this software-to-be, it is event-driven so the system is waiting in a loop for emerged events (user requests). For example, an user may want to search for the hot city New York City in the search bar, before this request, the system is waiting in a certain a loop for interruption, after receiving the interruption, the system jumps out of the waiting loop and executes appropriate subroutines. The designed system-to-be is a real time system, which means the system would continuously download tweets, hashtag as well as user profiles from Twitter and store valid information in the local Twitter database. This system- to-be is not a multiple threads application.

11.6 Hardware Requirements

To achieve full functionality, the server side needs a server computer for providing local Twitter database. The computer can run basic database as well as Java IDE. It should have enough disk storage (for example, 4 Gbytes hard disk space) and be able to perform network communication. For the client side, it needs a normal computer that can open websites and access to the Internet.

12 Algorithms and Data Structures

12.1 Algorithm

12.1.1 Estimation of population concerning health

Originally, we were planning to get all the tweets from one area (either a city or a state). Then, we planned to find out the number of tweets having physical exercise information by finding some keywords from the tweet content. Then we would have the total number of tweets "T" and the number of tweets that are health-related "A". In that case, we can calculate the percentage of people in that area who concern about health and exercise as shown in following formula:

$$\%\, Of\ Healthy\ Population = \frac{A}{T} * (Population\, Census) \tag{2}$$

As we start implementing it, we realized that this is impractical. The number of tweets from a city (for example NYC) is so large and the number of tweets mentioning health and exercise is so small. We have storage problem for the massive twitter data and we would get a lot of noisy tweets (not related to health) at the same time. Therefore, we switch to

some more practical ways. We only pull the tweets having specific set of hashtags. Although there is no any total number of tweets from one area for percentage calculation, we can still compare the difference in health related tweet number across different states. This also indicates the popularity of health and exercise across different states.

We collected all the tweets about health and exercise with a set of hashtags. After filtering out all the tweets having no information about location, we counted the number of tweets in US concerning about the health and exercise (noted as B). After researching online, we found that 8% of US people use twitter. Therefore, dividing the number of tweets from US by 8% (denoted as B/0.08), we get the number of people in US who exercise (E):

$$E = \frac{B}{8\%} \tag{3}$$

But this is not the total number of people in US who exercise because we havent collected all the health related tweets in US. The tweets we obtained is just a subset of all health related tweets from US. As we collect more data, the number of collected tweets will increase, so as the number of people in US who exercise. Our estimated number will get closer and closer to the true value as time goes. There are some limitations on the accuracy of our estimated number of people in the US who exercise. We can only get closer to the true value by may never be able to reach that number. Another factor is that there may be more than one tweets about exercise sent out by one person. This person is counted more than once. Future improvement on this project can refine the algorithm to count the number of twitter users who tweets about health and exercise instead of the number of tweets.

12.1.2 Word Cloud Algorithm

As for how to algorithimically generate the size for the word cloud, we heuristically assigned the following formula:

$$Size = (log_{10}(Frequency + 1) + 1) * 2 \tag{4}$$

We add a one to the frequency before taking the logarithm in the chance that there are no instances of a hashtag; a 1 is added after to make the weight, when multipled by 2, a little more meaningful (e.g. the size of the text is always greater than unity, at the very least, so it is legible).

12.1.3 Database Querying for Word Cloud

The plugin we used is called TagCanvas (http://www.goat1000.com/tagcanvas.php). This is an HTML5 plugin that allows us to plot the hashtags onto the map through HTML. The problem is that we need to generate the weights of the words ourselves. We can obtain rankings of our hashtags by first querying our database like so:
$tags = array('run','running','gym','jog',
'jogging','jogger','marsic','exercise',
'exercising','exercises','fitness','fit',
'fitfam','seenonmyrun','fitnessfriday',
'fitforlife','mefirst','gymtime','healthy',

'bodybuilding','chest','workout','getfit',
'active','healthychoices','diet','cardio',
'strong','training','fitnessaddict','fitspo',
'instahealth','trailrunning', 'trailrunner',
'trailrun', 'fitspiration', 'fitnessmotivation',
'gettingfit','dreambody','fitnessgoal',
'resultssofar','transformation','goal',
'dontgiveup', 'weightloss', 'morningrun',
'workoutsoicaneat','TFLers','tflers','gymlife',
'trainhard','grow','bulk','squat','squats',
'instafitness','ripped','swole','muscle',
'shredded','pushup','pushups','sweat',
'grind','fitnessgear','pushpullgrind','bigbench',
'fitgram','pullup','pullups','gymrats','eattogrow',
'physique','nikeplus','nike+','fitnessmodel',
'fitnessaddict','trainer','yoga','ironaddicts',
'lifting','addictedtoiron','bootcamp',
'workout_routines','strengthtraining',
'smashfit','squash','swimming','biking','cycling',
'losing_weight','keepfit');

$partial = "SELECT COUNT(*) FROM tweet_tags WHERE tag = "';
$count = 0;
for ($index = 0; $index ¡ count($tags); $index++) {
$query = $partial;
$query = $query.$tags[$index]."'";
$result = mysql_query($query);
$value = mysql_fetch_row($result);
$freq[$index] = $value[0];
}

So we are explicitly searching for our hashtags (because we have many, many hashtags in the database; were interested in seeing how well OUR tags are performing, not all the tags we have just yet). We can obtain how many times they occur in the tables this is the $freq variable.

Then on the data weighting size, we determine the tag size heuristically by doing the following:
data-weight = ' ".(ceil((log($freq[$index]+1))+1)*2)

- Take the logarithm (base 10) of the frequency of the hashtag.
- Add 1 to it to give it some size.
- Round it up.

- Add one again.
- Multiply by 2.

This was done experimentally and it seemed to generate satisfactory sizes in relation to the frequency of the hashtags and the size of the tag cloud we used.

12.2 Data Structure

The system we implemented stores a variety of values that may or may not need to be referenced by the system for any one of the use cases detailed earlier. These values go without saying at this point; we need to store user data and tweet data and require a data structure that is appropriate to the task. Simplistic data structures will not suffice for this project because speed and modularity is a factor in improving the user experience and the system performance. The following data structures were under consideration by us:

- Array
  - This is one of the simplest data structures available. We can map an output according to an integer ID. But the size of the array is fixed; it cant be varied and must be final. So if we were to store our data into the array wed need to pre-allocate the size and if it got too small wed have to create another array and copy all the data over. Not ideal.
- Queue
  - An ordered list of elements where the principal operations can only be performed on the end (tail) or front (head) of the data structure. This is a First-In-First-Out (FIFO) data structure that wed access through the use of pointers to objects in the list (head and tail). This isnt ideal for the storage because the operations can only be performed at the ends of the list and we may yet need objects in between.
- List
  - This is highly similar to the Queue, only that it is much easier to perform searching, addition, and deletion operations.
- Map
  - A map is a data structure where several variables of different types are stored in an abstract way and need to be referenced or pulled out according to a key pair value. Addition, removal, modification, and searching is quite easy with this data structure.
- Tree
  - A tree is an abstract data type where nodes contain a series of values along with a pointer to the children of that node. Its very fast to search for objects within the tree, making it optimal for us. Disadvantages are that nodes can only really access points that it has pointers to; they cant reach the children of other nodes.

- Vector
  - This is a dynamic array that is random access and whose size is not fixed. However, it is not possible to insert at random points.

After considering the above data structures, we decided to store the user information and characteristics in a Map data structure because there are several fields that are easy to get if you request the right key (password, name, et cetera). The Tweets we decided to store in a vector because they are mostly un-ordered (the hashtags are always the same for a given tweet set) and the dynamic size keeps us from allocating too much or too little for a given search.

13 User Interface Design and Implementation

The original mockup for our user interface from Report #1 can be seen on the next page:

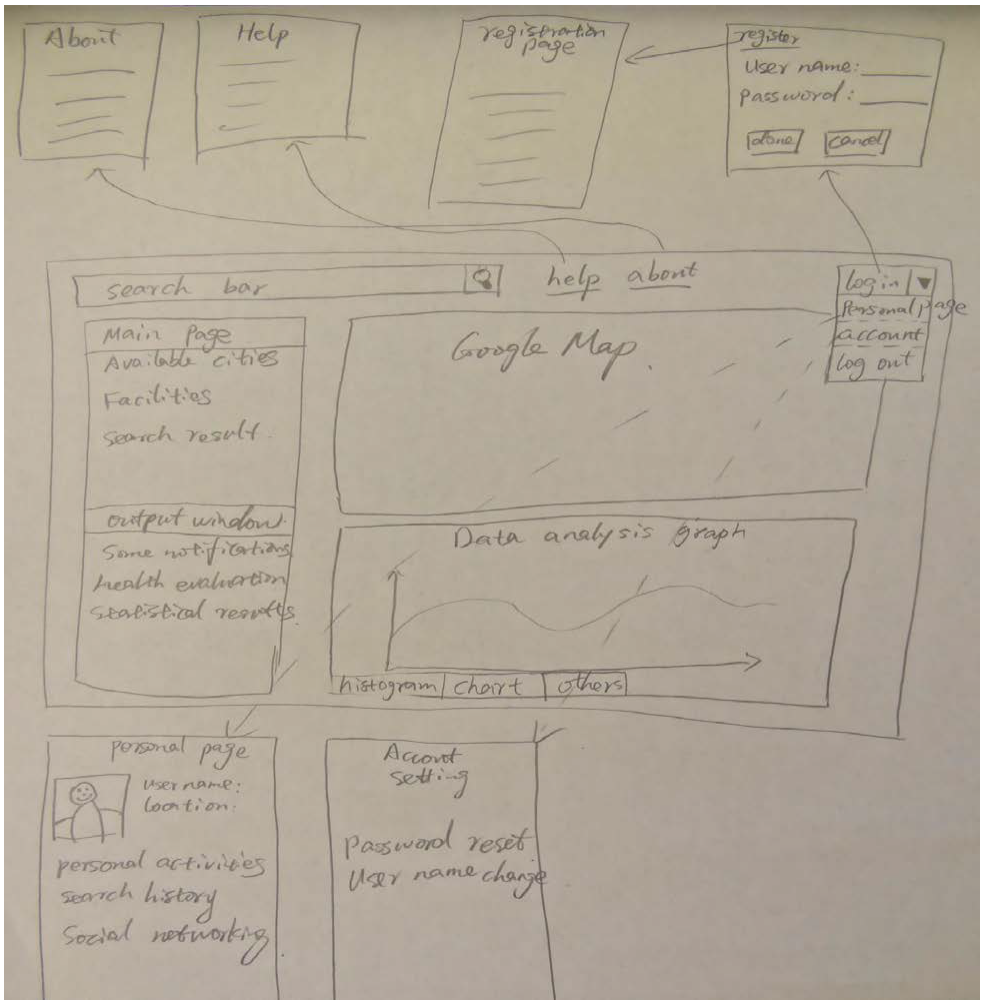


Figure 26: Original Mockup

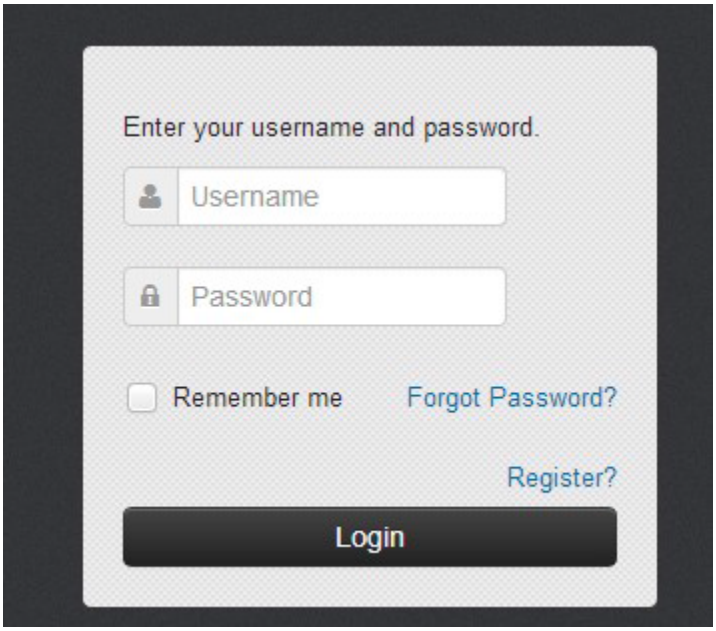
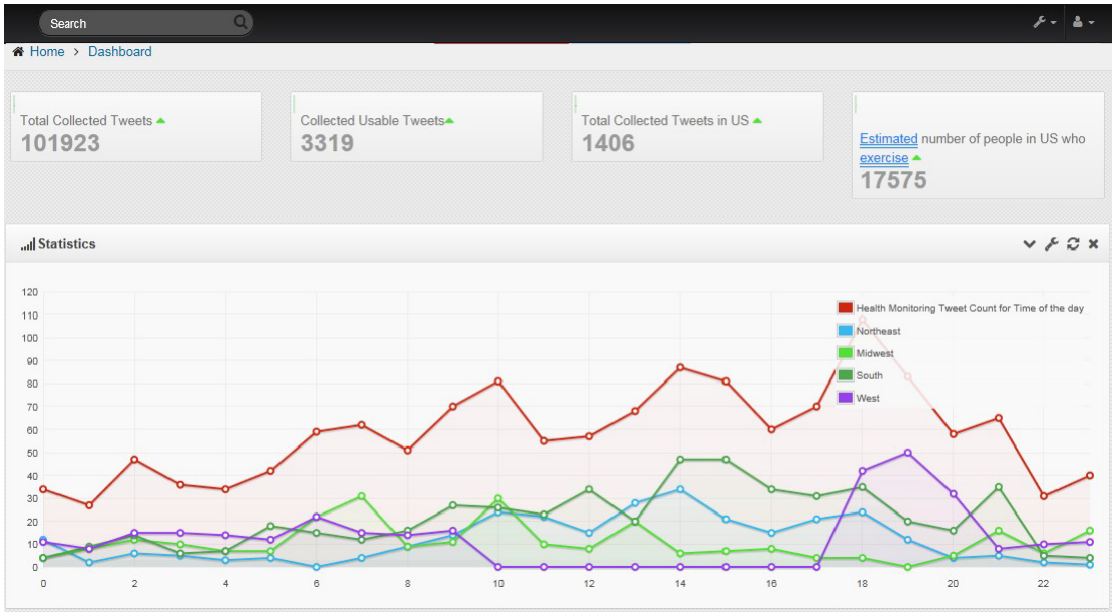
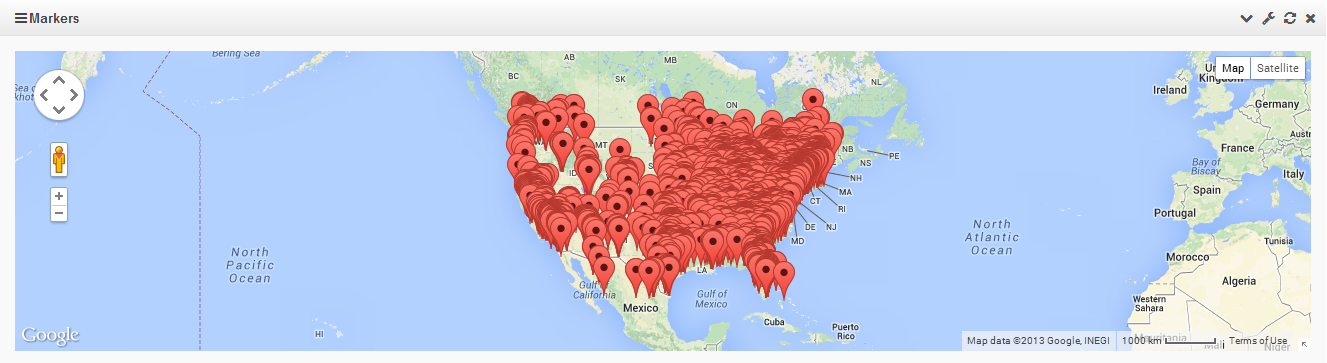
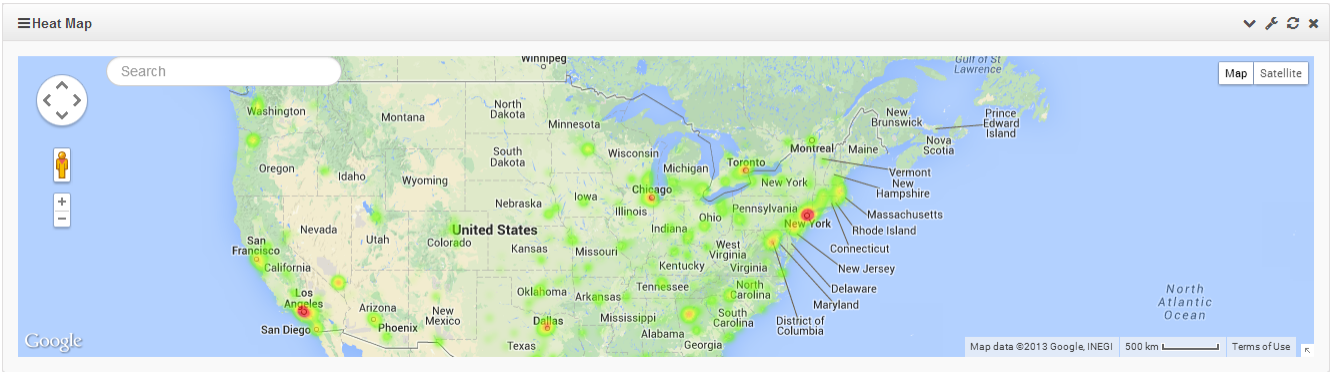


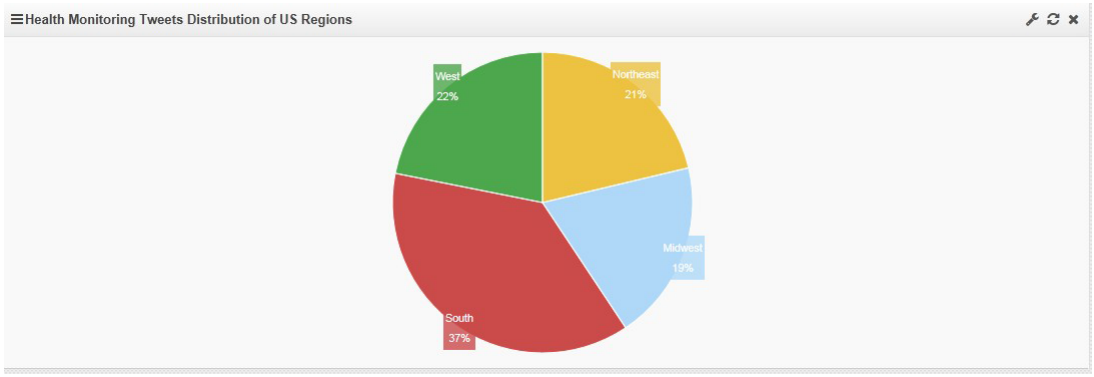
Figure 27: Login UI

We kept the same Login UI.




Markers
Map
Satellite
North Pacific Ocean
North Atlantic Ocean
Mexico
Gulf of California
Gulf of Mexico
Cuba
Puerto Rico
Ireland
France
Spain
Portugal
Germany
Italy
Morocco
Algeria
Tunisia
Western Sahara
Google
Map data ©2013 Google, INEGI
1000 km
Terms of Use


Heat Map
Search
Map
Satellite
United States
Washington
Montana
North Dakota
Minnesota
Oregon
Idaho
Wyoming
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Chicago
Nevada
Utah
Colorado
Kansas
Missouri
Indiana
Ohio
Pennsylvania
New York
California
San Francisco
Los Angeles
San Diego
Arizona
New Mexico
Phoenix
Oklahoma
Arkansas
Texas
Dallas
Mississippi
Alabama
Georgia
Kentucky
Tennessee
West Virginia
Virginia
North Carolina
South Carolina
Maryland
District of Columbia
Delaware
New Jersey
Connecticut
Rhode Island
Massachusetts
Vermont
New Hampshire
Maine
Montreal
Toronto
Winnipeg
Gulf of St Lawrence
Prince Edward Island
Nova Scotia
New Brunswick
North Atlantic Ocean
Google
Map data ©2013 Google, INEGI
500 km
Terms of Use


Health Monitoring Tweets Distribution of US Regions
West
22%
Northeast
21%
Midwest
19%
South
37%

Tag Cloud
exercise
fitness
fitfam
healthy
fitforlife
training
active
cardio
weightloss
squats
gymlife
motivation
yoga
sweat
fitnessmodel
bulk
cycling
instahealth
goal
grow
gymrats

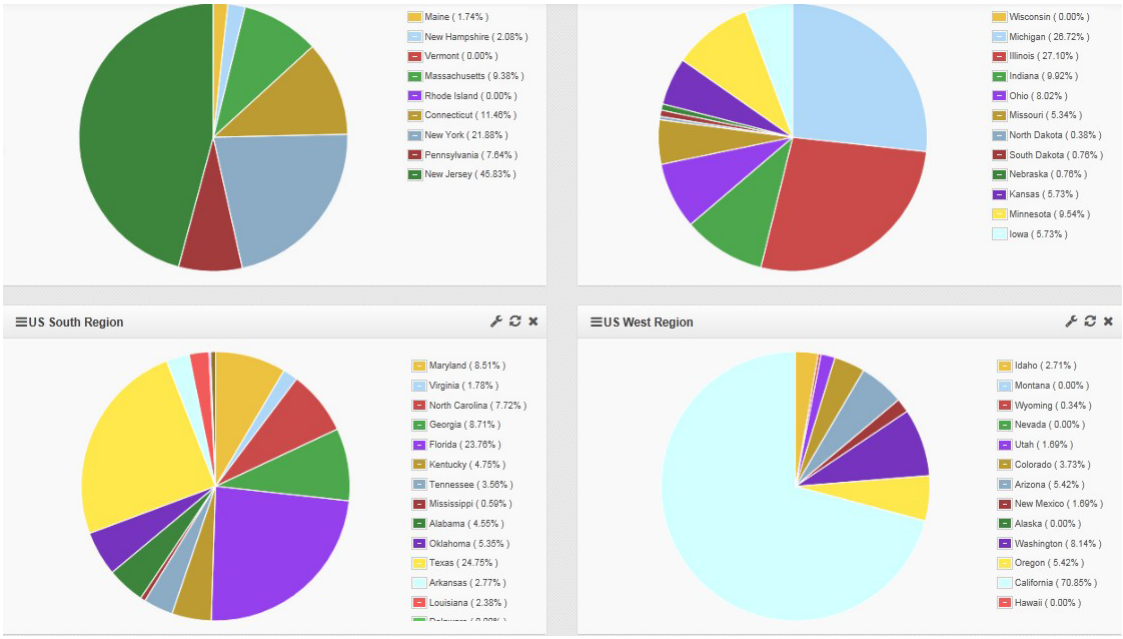

Maine (1.74%)
New Hampshire (2.08%)
Vermont (0.00%)
Massachusetts (9.38%)
Rhode Island (0.00%)
Connecticut (11.46%)
New York (21.88%)
Pennsylvania (7.64%)
New Jersey (45.83%)
Wisconsin (0.00%)
Michigan (26.72%)
Illinois (27.10%)
Indiana (9.92%)
Ohio (8.02%)
Missouri (5.34%)
North Dakota (0.38%)
South Dakota (0.76%)
Nebraska (0.76%)
Kansas (5.73%)
Minnesota (9.54%)
Iowa (5.73%)
US South Region
Maryland (8.51%)
Virginia (1.78%)
North Carolina (7.72%)
Georgia (8.71%)
Florida (23.76%)
Kentucky (4.75%)
Tennessee (3.56%)
Mississippi (0.59%)
Alabama (4.55%)
Oklahoma (5.35%)
Texas (24.75%)
Arkansas (2.77%)
Louisiana (2.38%)
US West Region
Idaho (2.71%)
Montana (0.00%)
Wyoming (0.34%)
Nevada (0.00%)
Utah (1.69%)
Colorado (3.73%)
Arizona (5.42%)
New Mexico (1.69%)
Alaska (0.00%)
Washington (8.14%)
Oregon (5.42%)
California (70.85%)
Hawaii (0.00%)

Figure 28: Whole UI

In our UI part, we kept the basic structure but modified the functionality. We removed the hyperlinks from the dashboard and left all of the functions on the main page. We designed several data analysis options including a pie chart breakdown of tweets, a heatmap for the distribution, markers on the maps, and a graph of tweet volume versus time of day aggregated over a period. The user effort with this screen is quite small. The webpage is clean and simple; it is easy for the user to find exactly what he or she is looking for. Everything they need is clearly labeled and the websites modular design makes it easy for the user to run the services. Everything here does not require extensive explanation.

Figure 29: Cloud Example 1

Figure 30: Cloud Example 2

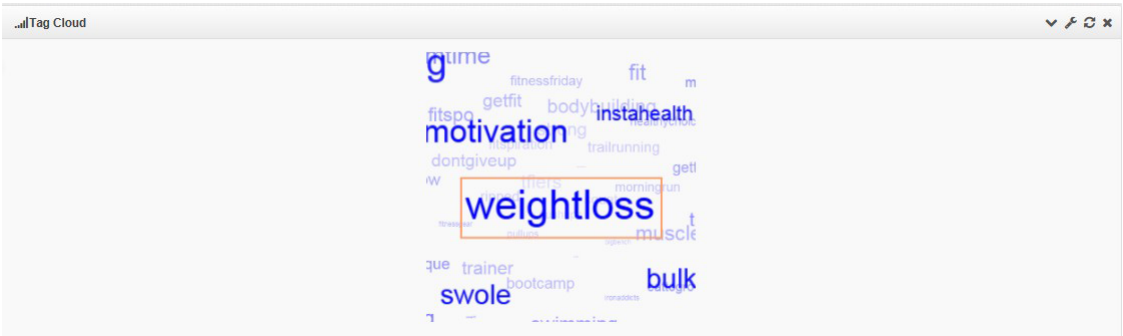


Figure 31: Cloud Example 3

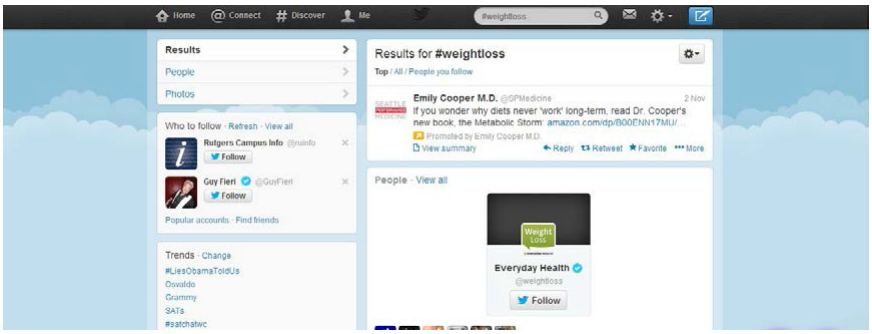


Figure 32: Cloud Example 4

Running Word Cloud function:
1. NAVIGATION: total 5 mouse movements, as follows.

- Move cursor to the chosen word cloud.
- Move cursor to find the chosen word if not in this page.
- Scroll mouse.
- Click the chosen word cloud.

- Click interested info

2. Function display:

- Move mouse to see the word cloud move with the cursor.
- Scroll mouse, the word cloud would change its size by shrinking or magnifying.
- Provide extra explanation with each word cloud to connect with Twitter.

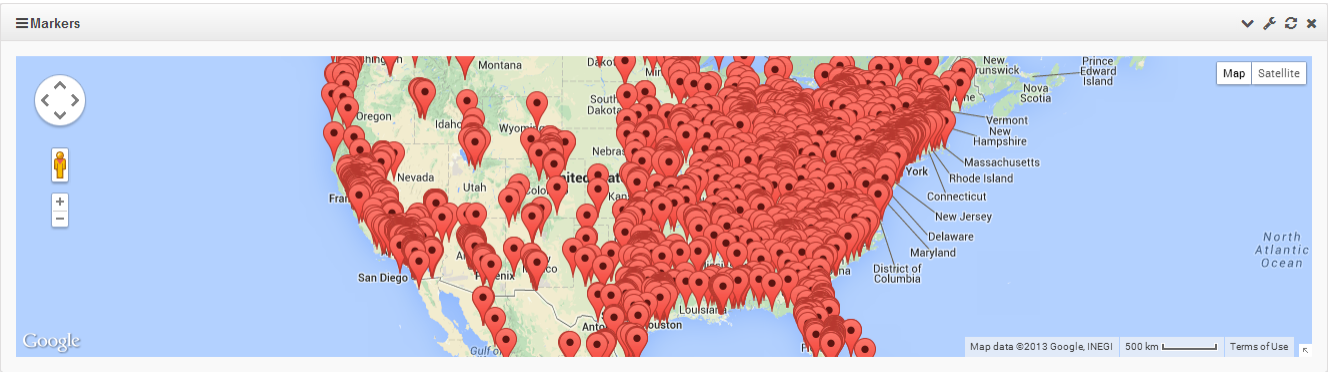


Figure 33: Markers

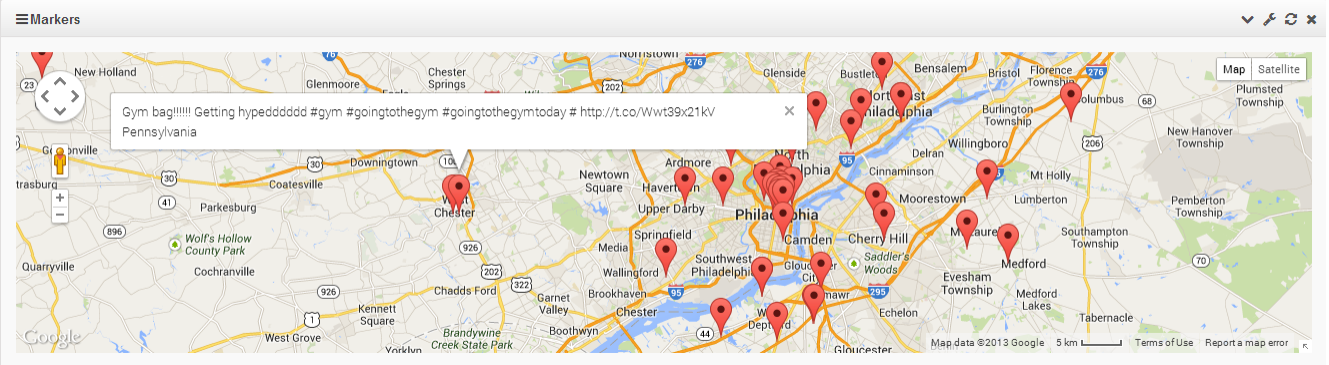


Figure 34: Markers Example

Running Viewing map function.
1. NAVIGATION: total 3 mouse movements, as follows:

- Move cursor to the chosen place.
- Scroll mouse.
- Move cursor to chosen location.

2. Function display:

- Move mouse to see the map displaying sports map.

- (Figure 11.9 Markers).
- Scroll mouse, the map would change its size as shrink or magnify.
- Move sursor to the mark, our website will display more info automatically.

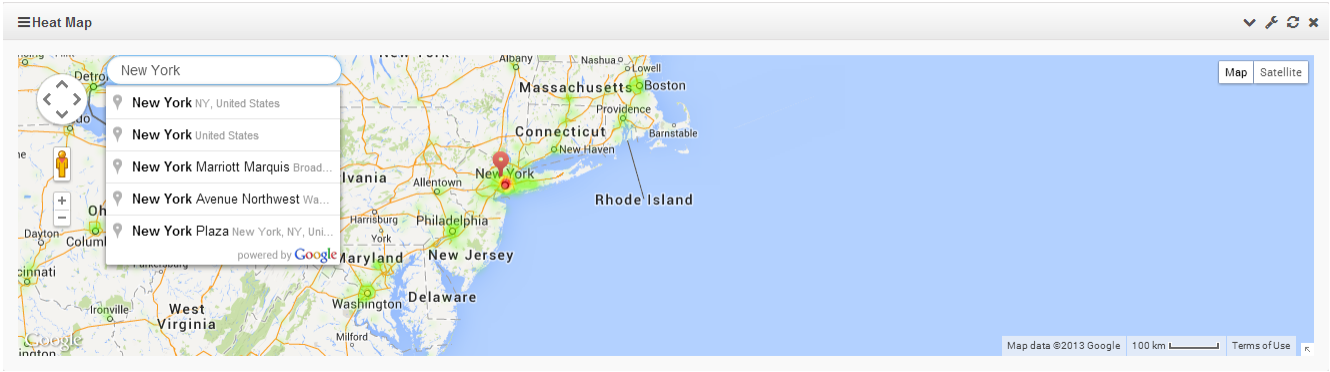


Figure 35: Search Example 1

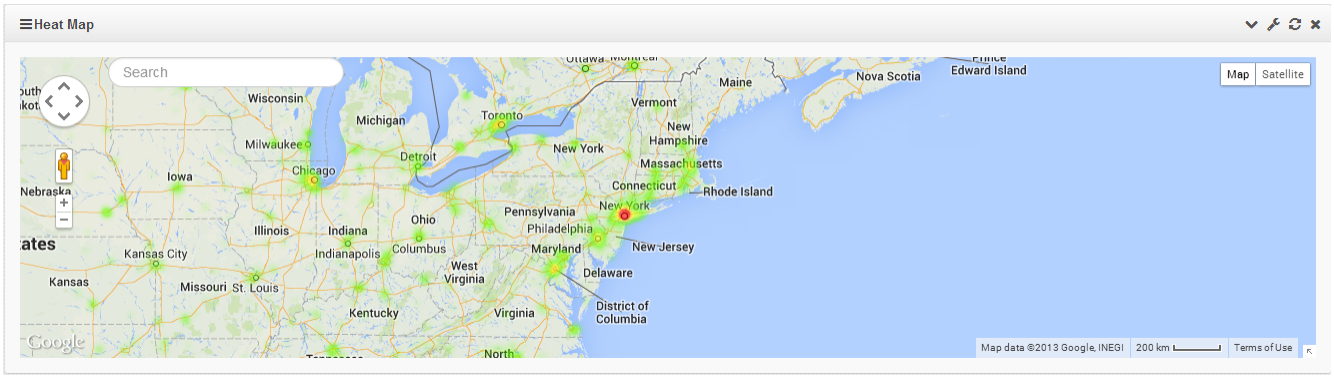


Figure 36: Search Example 2

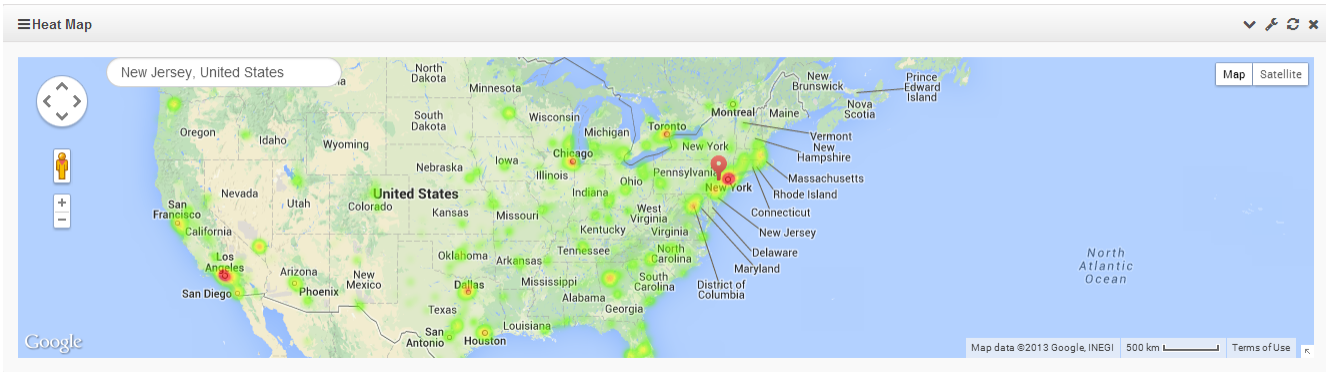


Figure 37: Search Example 3

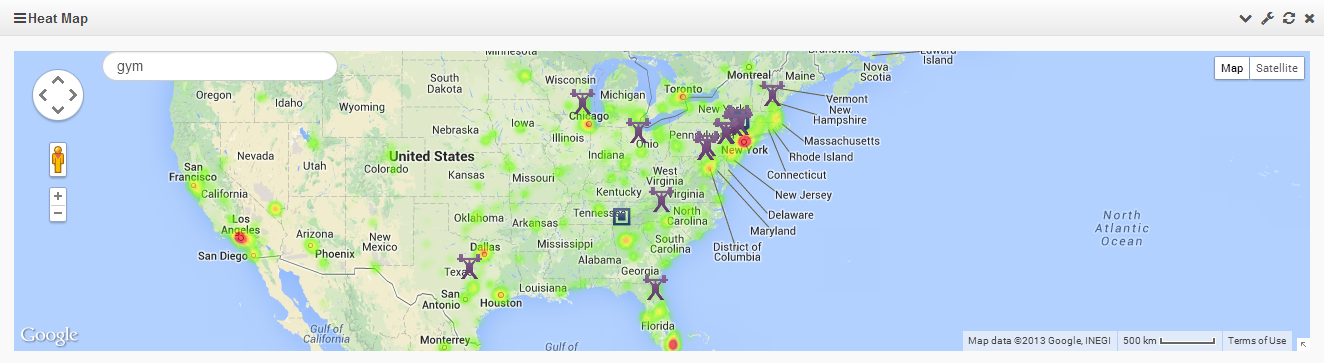


Figure 38: Search Example 4

Running Search function.
1. NAVIGATION: total 5 mouse movements, as follows.
i) Search without key words

- Move cursor to search box.
- Print searched place.
- Move cursor to map diagram.

ii) Search with key words

- Move cursor to search box.
- Print searched place with key word.
- Move back to map diagram.

Function display:

- Move cursor to the search box to input a place.
- View the searched map on the map diagram.
- Move cursor to the search box to input a place with key word.
- View the searched map with marked key word situation on the map diagram.

14 Design of Tests

14.1 Test Cases

- UC#1 Searching for Locations and Facilities

  This use case should enable the user to search for locations and facilities. For location search, the functional system should display results in the form of graphical analysis,

visualization through a Google MapFragment with tweets labeled as red dots, and statistical results with percentages showing the health population of the location. For facility search, the map should display available facility locations across the United States, showing the distribution of it over several cities.

- UC#2 Viewing Statistical Breakdown

  The user needs to navigate to the website and see whether or not the pie charts are being split into statistical values for the contiguous United States. If there is no breakdown, then the server is either unable to connect with Twitter, Google, or the website/database doesn't have tweet data.

- UC#3 Viewing Results

  The user needs to navigate to the website and see whether or not the results counter is changing across an hour. If there is no breakdown, then the server is either unable to connect with Twitter, Google, or the website/database doesn't have tweet data.

- UC#4 Viewing Map

  The user needs to navigate to the website and see whether or not the maps are displaying correctly with heat on the United States along with markers. If there is no breakdown, then the server is either unable to connect with Twitter, Google, or the website/database doesn't have tweet data.

- UC#5 Viewing Word Cloud The user needs to navigate to the website and see whether or not the word cloud is being displayed correctly. If there is no word cloud, then the server is either unable to connect with Twitter or the website/database doesn't have tweet data.

14.1.1 Deprecated Use Cases

These use cases have been deprecated due after updating our goals but we leave them here on the instruction that they should be kept.

- UC#2 Selecting Hot Cities

  This is another user or member input option as selecting hot cities instead of searching through search bar. The test should make sure the system gets what the user selected, and make sure that the system has a good user interface to avoid any possible mistakes due to in-appropriate operation.

- UC#5 Accessing Personal Page

  This use case tests functionality of the personal page. There are several processes that occur when its being accessed. The test should make sure the system gives full consideration on whether the user is registered before logging in, the verification of the identity, whether the searching algorithm for this user's page is efficient, and whether the interface of the personal page has any flaw.

- UC#6 Editing Personal Information

  This use case test should focus on the UI and data connection with member database. The test should make sure whether the information is successfully updated if the logged in user (member) has changed his information. A lot of emphasis should also be put on the user interface testing to make sure the system functions correctly.

- UC#7 Sending Messages

  In order to send messages, the user has to be a member of our software system. The test should make sure the sender is a registered user after sending message and at the same time, the receiver should be notified. The message should be sent without error. The system should also take into account possible transmission errors.

- UC#8 Viewing Search History

  This is also inside the personal page. Viewing search history can be tested to make sure the most recent member searches can be saved into the database. The test should make sure the system handles the search history correctly when there are a lot of entries.

- UC#9 Changing Account Settings

  This allows the user to change their username or password. The test should make sure whether the password can be reset. Members can also edit the username. The system should be tested on three kinds of changing scenarios: changing username, changing password, and changing both username and password.

- UC#10 Registering

  Any user can register to be a member to access some additional functions. Testing on registration should make sure the user is added into the system member database successfully. The registered member should not be registering again, which is also a part of the test.

- UC#11 Backup Member Data

  This test should make sure the member data is backed up periodically to another database in case of runtime failure.

- UC#12 Deleting Member Account

  As stated in the user case description in previous section, deleting member account has two options depending on whether the member wants to permanently delete the account or just make the account invisible to others. The test should consider both scenarios.

- UC#13 Viewing Map

  This is visualization test of the Google MapFragment object. The test should make sure the map can be easily manipulated. The user should have an option to request the display of partial data if the data set is too big. However, the user can still obtain full statistical results from the output window.

- UC#14 Viewing Word Cloud

  This is a dynamic graphic on the key word from twitter and can be displayed in a globular figure, it can change size and position with mouse and connected to detailed information with clicking.

- UC#15 Viewing Line Chart

  This is a Line chart to display the average sport time in different place, it updated over time, and implies local lifestyle and sport degree.

- UC#16 Viewing fan chart

  This is a fan chart to displace sport degree in every single state and for other appointed region, and also display the ratio. We also display some dynamic animation effect on move cursor in each section.

14.2 Test Coverage

- UC#1 Searching for Locations and Facilities
  - Success
    - User inputs a location they want to query. The system undergoes the task of verifying if the location is valid and can be displayed. When the match occurs, the MapFragment is updated along with other relevant portions of the user interface.
    - User inputs a facility they want to query. The system undergoes the task of verifying if the facility is valid and can be displayed. When the match occurs, the MapFragment is updated along with other relevant portions of the user interface.
    - User inputs a friend they want to search for. The system undergoes the task of verifying if the friend is valid and if a list of matches can be shown on the screen.
  - Failure
    - User inputs a location but the system is unable to verify it. It displays a "No Results Found" error message and waits for new input from the user.
    - User inputs a facility but the system is unable to verify it. It displays a "No Results Found" error message and waits for new input from the user.

- UC#2 Selecting Hot Cities
  - Success
    - User selects a hot city that is available from a list on the screen. The system checks the available city and updates the statistical data accordingly.
  - Failure

        * User selects a hot city but the system is unable to verify it. It displays a No Results Found error message and waits for new input from the user.

- UC #2, #3, UC#4, UC#5 Viewing Graphical (Data, Results, Map, Word Cloud)
    - Success
        * The object under question in the above list delimited by "/" will correctly display to the screen if the server is able to interface with the website and update the information content on the screen.
    - Failure
        * The website is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.

14.2.1 Deprecated Cases

- UC#2 Selecting Hot Cities
    - Success
        * User selects a hot city that is available from a list on the screen. The system checks the available city and updates the statistical data accordingly.
    - Failure
        * User selects a hot city but the system is unable to verify it. It displays a No Results Found error message and waits for new input from the user.

- UC#6 Editing Personal Information
    - Success
        * The user will opt to change the information stored in the database that correlates to their personal profile. They can change their email, location, gender, age, et cetera. If done correctly, the database will be updated with the new values and the screen will refresh to show that.
    - Failure
        * The server is unable to change their location. An error message is displayed on the screen and requests that the user try again.
        * The server is unable to change their gender. An error message is displayed on the screen and requests that the user try again.
        * The server is unable to change the age. An error message is displayed on the screen and requests that the user try again.
        * The website is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.
        * The website screen doesnt refresh to show the updated information.

        * The website screen refreshes and the data is changed in the database but the information displayed remains unchanged.

- UC#7 Editing Personal Information
    - Success
        * The user will select another user they wish to send a message to. If executed correctly, that message will be sent through the website to the other users inbox and that user will receive a notification that a message was sent.
    - Failure
        * The website is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.
        * The message is correctly sent but the notification about a new message is not displayed.
        * The message appears in the users chat portlet but does not appear in the inbox.

- UC#9 Changing Account Settings
    - Success
        * The user will opt to change the information needed to log into the website. They can change their username or password, et cetera. If done correctly, the database will be updated with the new values.
    - Failure
        * The server is unable to change their username. An error message is displayed on the screen and requests that the user try again.
        * The server is unable to change their password. An error message is displayed on the screen and requests that the user try again.
        * The website is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.

- UC#10 Registering
    - Success
        * The user will enter their username and password on the registration page and hit submit. This will succeed if there is no conflict with the system.
    - Failure
        * The website is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.

        * The username is taken by another user. The system will request that they try again with another username.
        * The password is taken by another user. The system will request that they try again with another password.

- UC#11 Backup Member Data
    - Success
        * The administrator opts to back up the member data and if it is properly copied to another database then the case is successful.
    - Failure
        * The system is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.
        * The database it is attempting to copy to does not exist or the server is out of space.

- UC#12 Deleting Member Account
    - Success
        * The administrator opts to delete another members account and it is removed from the system.
    - Failure
        * The system is unable to communicate with the server. An error message is displayed on the screen and requests that the user check their connection or try again.
        * The account doesnt exist in the database. An error message is sent back to the console.

- UC#14 Viewing Word Cloud
    - Success
        * The website display all word Cloud integrated and clearly.
        * User could change the size with scroll the mouse.
        * The word could would move and rotate with the movement of cursor.
        * User could get more info with clicking every single word cloud.
    - Failure
        * The website could no display the word cloud or only some of them.
        * The word cloud is not dynamic, which could not move with cursor.
        * Failed to connect with the twitter or connect to irrelative info.

- UC#15 Viewing Line Chart

- Success
  - The website display line chart integrated and clearly. The percentage of different US regions could be displaced as tendency with different time to illustrate the change in one day.
- Failure
  - The website could no display the line chart or only some of them.
  - The line chart is not dynamic, which could not show the tendency of one day.

- UC#16 Viewing fan chart
  - Success
    - The website display fan chart integrated and clearly.
  - Failure
    - The website could no display the fan chart or only some of them.

15 History of Work, Current Status, and Future Work

15.1 Plan of Work

The Plan of Work is illustrated in the two figures below.

	Task Name	Duration	Start	Finish
	Proposal	6 days	Mon 10/14/13	Mon 10/21/13
✓	**First report**	**18 days**	**Sun 9/22/13**	**Tue 10/15/13**
✓	**part 1**	**9 days**	**Sun 9/22/13**	**Wed 10/2/13**
✓	Customer Statement of Requirements (CSR)	4 days	Sun 9/22/13	Wed 9/25/13
✓	System Requirements	4 days	Thu 9/26/13	Tue 10/1/13
✓	Project Management and References	1 day	Wed 10/2/13	Wed 10/2/13
✓	**Part 2:**	**5 days**	**Thu 10/3/13**	**Wed 10/9/13**
✓	Functional Requirements Specification	3 days	Thu 10/3/13	Mon 10/7/13
✓	User Interface Specification	4 days	Fri 10/4/13	Wed 10/9/13
✓	**Part 3:**	**5 days**	**Wed 10/9/13**	**Tue 10/15/13**
✓	Domain Analysis	4 days	Wed 10/9/13	Mon 10/14/13
✓	Plan of Work	2 days	Fri 10/11/13	Mon 10/14/13
✓	summary	1 day	Tue 10/15/13	Tue 10/15/13
✓	**Second report**	**16 days**	**Wed 10/16/13**	**Wed 11/6/13**
✓	**Part 1**	**9 days**	**Wed 10/16/13**	**Sat 10/26/13**
✓	Interaction Diagram	4 days	Wed 10/16/13	Mon 10/21/13
✓	**Part 2**	**7 days**	**Tue 10/22/13**	**Wed 10/30/13**
✓	Class Diagram and Interface Specification	4 days	Tue 10/22/13	Fri 10/25/13
✓	System Architecture and System Design	4 days	Fri 10/25/13	Wed 10/30/13

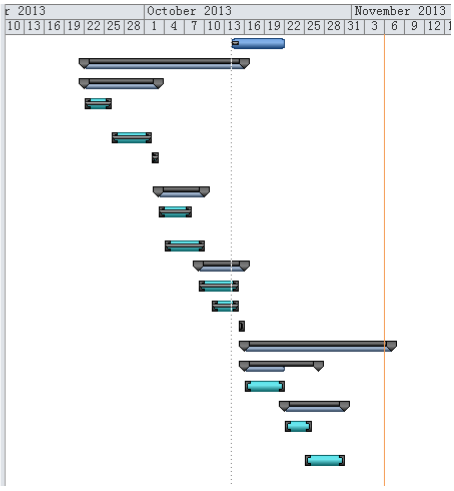
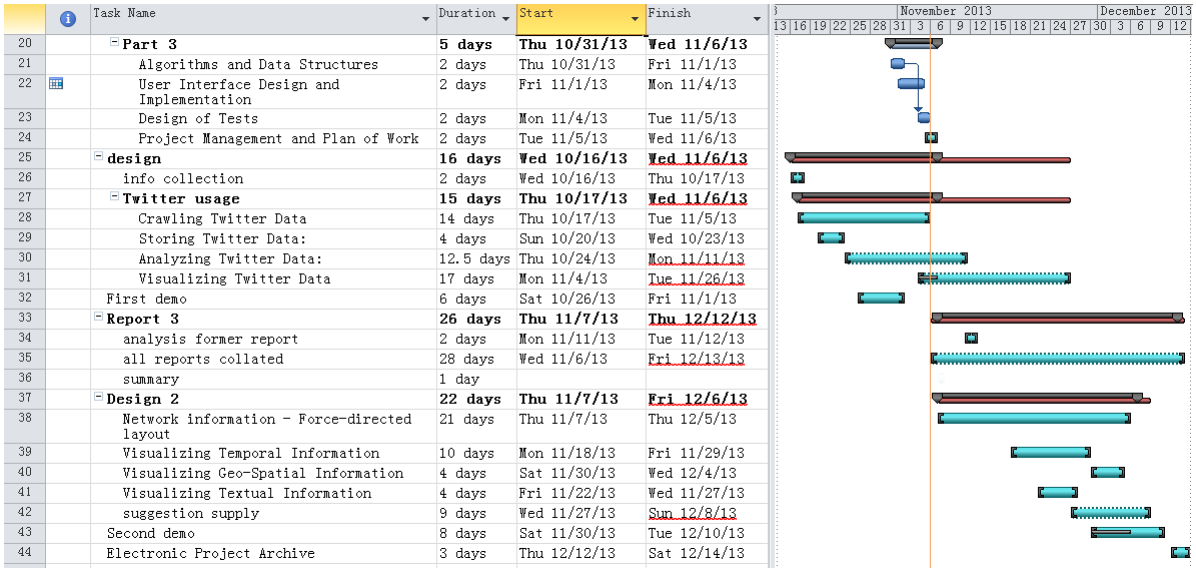


Figure 39: Plan of Work 1



	Task Name	Duration	Start	Finish
20	**Part 3**	**5 days**	**Thu 10/31/13**	**Wed 11/6/13**
21	Algorithms and Data Structures	2 days	Thu 10/31/13	Fri 11/1/13
22	User Interface Design and Implementation	2 days	Fri 11/1/13	Mon 11/4/13
23	Design of Tests	2 days	Mon 11/4/13	Tue 11/5/13
24	Project Management and Plan of Work	2 days	Tue 11/5/13	Wed 11/6/13
25	**design**	**16 days**	**Wed 10/16/13**	**Wed 11/6/13**
26	info collection	2 days	Wed 10/16/13	Thu 10/17/13
27	**Twitter usage**	**15 days**	**Thu 10/17/13**	**Wed 11/6/13**
28	Crawling Twitter Data	14 days	Thu 10/17/13	Tue 11/5/13
29	Storing Twitter Data:	4 days	Sun 10/20/13	Wed 10/23/13
30	Analyzing Twitter Data:	12.5 days	Thu 10/24/13	Mon 11/11/13
31	Visualizing Twitter Data	17 days	Mon 11/4/13	Tue 11/26/13
32	First demo	6 days	Sat 10/26/13	Fri 11/1/13
33	**Report 3**	**26 days**	**Thu 11/7/13**	**Thu 12/12/13**
34	analysis former report	2 days	Mon 11/11/13	Tue 11/12/13
35	all reports collated	28 days	Wed 11/6/13	Fri 12/13/13
36	summary	1 day		
37	**Design 2**	**22 days**	**Thu 11/7/13**	**Fri 12/6/13**
38	Network information - Force-directed layout	21 days	Thu 11/7/13	Thu 12/5/13
39	Visualizing Temporal Information	10 days	Mon 11/18/13	Fri 11/29/13
40	Visualizing Geo-Spatial Information	4 days	Sat 11/30/13	Wed 12/4/13
41	Visualizing Textual Information	4 days	Fri 11/22/13	Wed 11/27/13
42	suggestion supply	9 days	Wed 11/27/13	Sun 12/8/13
43	Second demo	8 days	Sat 11/30/13	Tue 12/10/13
44	Electronic Project Archive	3 days	Thu 12/12/13	Sat 12/14/13

Figure 40: Plan of Work 2

15.2 Project Coordination and Progress Report

- We succeeded in implementing all use cases that weren't related to user specific functionality (e.g. messaging).
- The login page works as static content.
- Website is fully dynamic; updates with Twitter data many times an hour.
- Data analysis is performed through a variety of graphical mechanisms; maps, charts, word cloud, et cetera.

15.3 Future Work

- Implement the login and user management part.
- Improve the maintenance routine for our system.
- Increase functionality such as viewing search history, providing individual suggestions, sending messages, adding social networks for members, etc.

15.4 Breakdown of Responsibility

15.4.1 The breakdown would expected to be as follows:

- Twitter API, Data Mining
  - Rui Xu, Xiaoyu Yu, Gradeigh Clark
- Google Map, sending messages, friend invitation.

  - Li Xu, Yihan Qian, Xianyi Gao

- Webpage design, Data analysis, database and server set up, main documentation writing.

  - Gradeigh Clark and Xianyi Gao

15.4.2 Merging the Contributions from Individual Team Members

Gradeigh and Xianyi took control of compiling the final report, doing the formatting, ensuring consistency, and uniform formatting and appearance. No extreme issues were encountered in compiling the report.

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